Facial Appearance and Its Association with Bio-Psychosocial Parameters in Healthy Men

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Abstract

Facial appearance represents a key source of social information about the personality and health of its wearer. The facial width-to-height ratio (fWHR) has been linked to dominance-related behavior and seems to be part of an evolved system of social dominance. Recent research indicates the perceived age, the age of another person estimated based solely on facial appearance, to be a valid biomarker for health and longevity. In the first study, we investigated the association between fWHR and various personality traits of social dominance. The fWHR was positively linked to physical aggression, psychopathy, and Machiavellianism, but only in men reporting low income. Furthermore, a positive interaction between fWHR and testosterone on narcissism was found. Our second study analyzed whether psychosocial resources for mental health are associated with the perceived age. Optimism, self-esteem, and relationship satisfaction were indirectly associated with a younger facial appearance. Mental health mediated the association between each psychosocial resource and facial appearance. In conclusion, the findings presented in this thesis emphasize the importance of taking into account bio-psychosocial factors when examining the link between facial appearance and complex personality traits as well as mental health.

Zusammenfassung

Das Gesicht repräsentiert eine Hauptinformationsquelle über die Persönlichkeit und Gesundheit seines Trägers. Die facial Width-to-Height Ratio (fWHR) wird insbesondere mit dominanzbezogenem Verhalten in Verbindung gebracht und scheint Teil eines evolutionären Systems der sozialen Dominanz zu sein. Das wahrgenommene Alter, das geschätzte Alter einer Person, scheint ein valider Biomarker für Gesundheit und Langlebigkeit zu sein. In der ersten Studie untersuchten wir den Zusammenhang zwischen der fWHR und verschiedenen Persönlichkeitsmerkmalen der sozialen Dominanz. Die fWHR hing positiv mit physischer Aggression, Psychopathie und Machiavellismus zusammen, aber nur bei Männern mit einem unterdurchschnittlichen Einkommen. Zudem wurde eine positive Interaktion zwischen der fWHR und Testosteron auf Narzissmus gefunden. Unsere zweite Studie untersuchte, ob psychosoziale Ressourcen der psychischen Gesundheit mit dem wahrgenommenen Alter zusammenhängen. Optimismus, Selbstwert und Beziehungszufriedenheit hingen indirekt mit einem jüngeren Aussehen zusammen. Die psychische Gesundheit mediierte den Zusammenhang zwischen den einzelnen Ressourcen und dem Aussehen. Die in dieser Arbeit präsentierten Ergebnisse betonen die Wichtigkeit, bio-psychosoziale Faktoren im Zusammenhang zwischen dem Gesicht und komplexen Persönlichkeitsmerkmalen sowie der psychischen Gesundheit mit zu berücksichtigen.

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Abbreviations

DA	Difference between chronological age and perceived age
FFM	Five-Factor Model
fWHR	Facial Width-to-Height Ratio
IPC	Interpersonal Circumplex
LOT-R	Life Orientation Test–Revised
MSES	Multidimensional Self-Esteem Scale
RAS	Relationship Assessment Scale
SF-36	Short-Form Health Survey
UV	Ultraviolet

1. Introduction

As one of the most anthropological traits, the human facial appearance is strongly influenced by many factors such as genetic inheritance (Peng et al., 2013), ethnicity (Guo et al., 2014), age (Chen et al., 2015), sex, or health (Kramer & Ward, 2010). Facial appearance inclines to be the primary target of attention when encounting another person (Palermo & Rhodes, 2007). As a result, the human face is conceivably the richest source of information about another person (Todorov, Said, Engell, & Oosterhof, 2008). It has been used as source of information ranging from the health status to specific personality traits of its wearer since very ancient civilizations. For example, *Mien Shiang* that literally means face (*mien*) and reading (*shiang*) has a venerated and well-documented history in China that can be dated back to 700 BC (Chen, 1994). Originally, the ancient Taoist alchemical practice involved understanding the individual's true nature and determining the character, behavior, and health potential (Wong, Soo, Ng, van Hasselt, & Tong, 2010). Face reading was also part of early Chinese Medicine as an aid to diagnose the health status and to determine appropriate treatments. Face reading was considered as an important diagnostic tool to gain knowledge of the personality of the patients as well as to get insight into the state of their health (Bridges, 2012). Face reading was not limited to the Chinese culture alone. In our latitudes, physiognomy formed part of the most ancient practical philosophy. The oldest known systematic treatise on physiognomy is attributed to Aristotle in 340 BC (Fridlund, 1994). Latin classical authors Juvenal, Suetonius, and Pliny the Elder made reference to the practice of physiognomy. The concept of physiognomy lies in the idea that an individual's character can be accurately judged on the basis of specific facial features (Lavater, 1850). Despite the dismissal of physiognomy as pseudoscience (Alley, 1988; Cohen, 1973; Porter, 2003), a strong belief exists that facial appearance does provide information about a person's personality, health, and future behavior (Hassin & Trope, 2000; Liggett, 1974). This phenomenon has also been termed as "kernel of truth hypothesis" (Berry & Finch Wero, 1993). Indeed, there is growing body of evidence suggesting that facial appearance may provide some valid information regarding a person's personality and health. As faces are processed largely holistically (Tanaka & Farah, 1993), modern research has focused particularly on whole face stimuli. Recent research has identified two key facial cues, the facial width-to-height ratio (fWHR) and the perceived age, in order to infer personality traits and the health status from the face.

The fWHR is a static morphological cue of the human face (Weston, Friday, & Liò, 2007) that has been shown to be positively associated with aggressive behavior (Carré & McGormick, 2008), deception (Haselhuhn & Wong, 2011), and psychopathy (Anderl et al., 2016). Therefore, having a great fWHR has been suggested to be a biological index of dominance-related personality traits. The relationship between fWHR and dominance-related behaviors can be influenced by other factors such as social status (Goetz et al., 2013) or testosterone (Lefevre, Lewis, Perrett, & Penke, 2013). However, there is a lack of empirical studies considering these potential influencing factors on the association between fWHR and dominance-related personality traits.

Perceived age, the estimated age of another person based on facial appearance, has been shown to be a valid biomarker for healthy aging and longevity (Christensen et al., 2009). The same study showed that 40 percent of the variation in perceived age is due to non-genetic factors. Accordingly, it is assumed that lifestyle factors can have significant long-term effects on perceived age (Gunn et al., 2015). In particular, a high social status, being married, non-smoking, and describing no depressive mood (Rexbye et al., 2006) as well as reporting financial stress (Agrigoroaei, Lee-Attardo, & Lachman, 2016) have been shown to be associated with a younger facial appearance in comparison to chronological age. To date, however, it is still unknown whether and how perceived age is associated with psychosocial resources for mental health.

The main aim of the present thesis is to gain knowledge about bio-psychosocial correlates of facial appearance in healthy men. More specifically, the proposed key facial cues, fWHR and perceived age, are investigated in two empirical studies. Both facial cues are drawn from face photographs. The first study is part of a larger project investigating risk and protective factors of vital exhaustion in men. The second study is part of a larger project focusing on healthy aging in men. Both research projects were implemented within the frame of the University Research Priority Program (URPP) Dynamics of Healthy Aging. In study I, in a sample of 109 vitally exhausted and apparently healthy men, the association between fWHR and self-reports of dominance-related personality traits and the influence of social status and testosterone on this association are investigated. In study II, in a sample of 223 healthy men, the role of psychosocial-resource factors in perceived age is analyzed.

The present thesis is composed of three main parts. The first part integrates the theoretical background and previous empirical research on facial appearance and its link to personality and health. Prior to focusing on the association of facial appearance with specific personality traits and states of health, the concepts of facial appearance, personality, and health are described separately. Due to the objective of investigating bio-psychosocial correlates of the male facial appearance, the primary focus of this thesis is research on men. Based on the theoretical background, the research questions of the two empirical studies are formulated. The second part is the core of the thesis and includes the presentation of the two empirical studies. In the third part of the thesis, the main results of the empirical studies are summarized, integrated, and discussed.

PART I: THEORETICAL BACKGROUND

2. The Concept of Facial Appearance

This chapter focuses on the definition and relevance of facial appearance. The chapter starts with the description of the facial features, as they represent the basis of facial appearance and are crucial for the perception and recognition of faces (Andrews, Davies-Thompson, Kingstone, & Young, 2010). The distinct analysis of facial features played a significant role in the flowering periods of physiognomy. With detection of a holistic processing of faces, modern research has investigated more complex whole face stimuli (Andrews et al., 2010; Tanaka & Farah, 1993). For this reason, the focus lies thereafter on holistic components of facial appearance. Additionally, the relevance of facial appearance is elucidated.

2.1 Definition of Facial Appearance

The modern human face began to evolve nearly 200'000 years ago, with the appearance of the homo sapiens in Africa (White et al., 2003; Wood & Leakey, 2011). The face is defined by a combination of structures heterogeneous in both anatomy and function. Seen from an anatomical perspective, facial appearance is to a high degree shaped by the convexities and concavities of the underlying facial bones (Prendergast, 2013). The craniofacial framework consists of the frontal bone superiorly, the bones of the midface, and the mandible inferiorly. The four apertures in the face are the two orbital apertures, the nasal aperture, and the oral aperture (Prendergast, 2013). The eyes, the mouth, and the nose serve as important facial cues for discrimination and recognition of faces (Andrews et al., 2010; Haig, 2013). Because these facial features are distinct and can be characterized independently, Rhodes (2013) labelled them as first-order features. In contrast, configurational features characterizing the spatial relations between first-order features, the position of first-order features, and information about face shape such as the fWHR constitute second-order features. Both first and second order features are relevant determinants of facial appearance. In addition, higher-level features are age, ethnicity, gender, or weight, whose values depend on a complex set of feature values. For instance, age might be a function of hair quantity, hair color, or skin texture (Rhodes, 2013).

Every human being shares the same array of eyes, nostrils, and mouth. These first-order features cluster up front and are the organs of the three checkpoint senses: sight, smell, and taste. The frontal positioning of the eyes enables binocular vision necessary to see in three dimensions. Like all higher primates, humans have necks and matched movable eyes, which enables panoramic vision. The eyes are often referred to as the psychological center of the face. Subjectively, we exist behind the eyes (McNeill, 2000). The visible eye is about one-sixth of the entire orb and it entails three interacting parts: white, iris, and pupil. Due to the contrast of white and the darker iris and pupil, eye movements are easily detectable. Since eyes contact air directly, eyelids with tear glands function as a tool to blink and to keep them wet (McNeill, 2000; Tsubota, 1998). The eyebrows and eyelashes are essential for sweat deflection. Furthermore, the eyelashes highlight the blink and the eyebrow

helps to signal emotions such as anger, surprise, or fear. The nose is located in the middle of the face and is the most variable part of the face. Since the human face is flat, the nose may gather scents rising from below to assay food. Furthermore, every animal with panoramic vision has a projection of itself that interrupts its view (McNeill, 2000). Bower (1974) arguments that human eyes compare the world against the nose. As the nose is always visible, it may help to position objects and to inform whether they or we are moving. The mouth is the body's main entry point and also the most plastic part of the face. The main function of the mouth is to test the quality of food (e.g. taste, texture, temperature, shape, etc.) before swallowing it. The mouth often rests, but once in motion, it can sigh, yawn, smile, laugh, drop open, pout, tremble, and tighten. While speaking, the mouth moves in endless ways: widening, opening, closing, puckering, protruding, retreating. Consequently, McNeill (2000) describes the mouth as the contortionist of the face. The mouth entails two facial transients: the teeth and the tongue. Teeth provide the only hard tissue of the human body directly visible in living individuals (Scott & Turner, 2000). The teeth and tongue are essential for both speech and feeding (Hiiemae & Palmer, 2003). The extrinsic and intrinsic muscles interact and control the shape of the tongue adeptly. Furthermore, the tongue's mucous membrane contains many taste buds to assay food (Collings, 1974). Further important facial features are the folds. The most notable folds in the face are the philtrum, nasolabial folds, chin, and lips. The philtrum is the shallow vale between the nose and upper lip (Latham & Deaton, 1976). The nasolabial fold is located at the junction of the cheek and upper lip (Rubin, Mishriki, & Lee, 1989), and is the keystone for the smiling mechanism (Rubin & Jackson, 1999). The chin seems to aid mastication and is required for the expression of the face shape. Without the chin, the lower face would merge with the neck, and face shape would blur. The lips are the transition zone between the dry skin of the face and the moist mucous membrane of the inner mouth. Their surface is thin enough to reveal blood below, which is why lips look red. The lips serve as border guards and enhance facial expression (McNeill, 2000). A relatively empty quarter in the face are the cheeks and forehead. The cheeks extend from the eyes to the nasolabial folds and cover the oral cavity (Robinson, 2014). The forehead seems to be the seat of intellect, doubtless due to the organ behind the front. Except for eyebrows and lashes as well as beards or mustaches, the face is bare and this apparently trivial fact has shaped our very nature as the face has become more articulate. The bare face greatly expanded the vocabulary, made messages clearer, subtler, and more varied. The face transformed into a dense, rapid information web, which led to super-social creatures (McNeill, 2000).

The above-described facial features form the basis of facial appearance. Research on face processing has demonstrated that faces are perceived largely holistically, rather than in a feature-by-feature fashion (Tanaka & Farah, 1993). Consequently, modern research on facial appearance has focused predominantly on whole-face stimuli, including sexual dimorphism, attractiveness, and perceived age. The human face is sexually dimorphic with sex differences in the size and shape of, and distance between, the jaws, lips, eyes, nose, and cheekbones (Farkas, 1981; Enlow, 1996). Masculine characteristics of facial features are a broad forehead, chin, jaw, and nose (Marečková´ et al., 2011), whereas facial femininity is characterized by large eyes, full lips, a small chin, and high

cheekbones (Re & Rule, 2015; Rhodes, 2006). There are considerable within-sex variations in these facial features leading faces to appear more feminine or masculine than the prototypical male or female faces. In men, facial masculinity has been used to infer specific personality traits from faces. For instance, masculine male faces are perceived as dominant and cold (Perrett et al., 1998). A broader face shape, in particular a higher facial width-to-height ratio, is linked to dominance and untrustworthiness (e.g. Mileva, Cowan, Cobey, Knowles, & Little, 2014). Masculinity and femininity are components of facial attractiveness. Femininity has consistently been evaluated as attractive in female faces (Rhodes, 2006), whereas the link between masculinity and attractiveness seems to be more complex (Penton-Voak et al., 2003). In addition to sexual dimorphism, there are other components of facial attractiveness, namely: symmetry and averageness, adiposity, and skin color (Re & Rule, 2015; Rhodes, 2006). These components of facial attractiveness have been used as cues of the health status of an individual. Perceived age constitutes another important whole-face stimulus tool to assess health, as it is sensitive to a number of facial features that are indicative of age (Rhodes, 2009).

2.2 Relevance of Facial Appearance

According to McNeill (2000), the face is the most important and mysterious surface we deal with. The face is like a window, instantly exposing the age, sex, character, health, and ethnicity of its wearer (Zebrowitz, 1997). It houses the five classic senses and adorns personal documents that require the identity verification, such as passports or driver's licenses. The face further represents the classic icon of power and authority and is depicted on coins, currency, stamps, or political posters. Especially in East Asia, the term "face" refers to one's status and dignity (Ho, 1976).

Each human face is unique and one of the most fundamental parts of the body for self-recognition and individual identity (Kim et al., 2013). The selection for individual identity signals has shaped patterns of facial diversity in humans (Sheehan & Nachnam, 2014). Consequently, faces show elevated phenotypic variation and lower between-trait correlations compared to other bodily traits (Sheehan & Nachnam, 2014). The face is a key feature used in social recognition and has a decisive impact on social interactions. Due to the frontal orientation of the eyes and their stereotypic vision, individuals interact mainly face-to-face (Heesy, 2004). Consequently, the face inclines to be the primary target of attention when one encounters another person and remains continuously available during social interaction (Palermo & Rhodes, 2007). The face is conceivably the most prominent and richest source of information about another person and suggested to be the most biologically and socially significant stimulus in the social environment (Re & Rule, 2015; Todorov, Said, Engell, & Oosterhof, 2008). Moreover, the face is emotionally significant to most individuals and represents an emotional stimulus regardless of its emotional expression, enabling us to distinguish friend from foe and providing valuable information for social interactions (Palermo & Rhodes, 2007). The ecological approach to person perception (Gibson, 1979) states that the function of face perception is to provide adaptive information about a specific individual and ensuing to serve adaptive

action (Zebrowitz & Montepare, 2006, 2008). Accordingly, the face contains a variety of information for adaptive social interactions with other people (Zebrowitz & Montepare, 2008). Thus, all faces, even so-called "neutral" faces, have emotional significance and have special access to visual attention (Palermo & Rhodes, 2007). Indeed, humans allocate their attention rather to faces (Ro, Russell, Lavie, 2001; Theeuwes & Van der Stigchel, 2006) and they detect and categorize faces faster than many other stimuli (Pegna, Khateb, Michel, & Landis, 2004). This initial preference for faces can be found already in early infancy (Frank, Amso, & Johnson, 2014). Brain areas specialized in processing facial stimuli underline the crucial role of facial appearance in social interactions (Haxby, Hoffman, & Gobbini, 2000). Due to highly efficient and specialized neural pathways involved in face perception and analysis, it is not surprising that people only need a tenth of a second to evaluate others based solely on facial appearance (Willis & Todorov, 2006; Bar, Neta, & Linz, 2006; Olivola & Todorov, 2010).

The evaluation of and interaction with other people is highly influenced by the facial appearance (Wolffhechel et al., 2014). As it is immediately and permanently available during social interaction, facial appearance is used as a source of information about another person. Specifically, inferences of personality and health are integral to social interactions. Personality attributes influencing decisions are inferred from facial appearance and are consequential in terms of real-world outcomes (Willis and Todorov, 2006). For example, facial appearance predicts criminal justice decisions (Wilson & Rule, 2015) and election outcomes (Little, Burriss, Jones, & Roberts, 2007; Todorov, Mandisodza, Goren, & Hall, 2005). When exposed to a disease, people evaluate themselves as less extraverted and exhibit avoidant tendencies in arm movements when viewing face photographs (Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010). Consequently, negative judgments of health may increase the risk of social isolation and stigmatization (Park, Schaller, & Crandall, 2007; Duncan & Schaller, 2009).

2.3 Summary

The face is important in many different ways: It houses the classical senses, and due to the frontal orientation of the eyes, it is the most prominent part of the body in individual identity and social interaction. Whole-face stimuli serve as information immediately available for generating inferences about personality (e.g. masculinity, face shape) and health (e.g. attractiveness, perceived age) of a particular person. As facial appearance has strong impacts on both the social interaction and evaluation of others, increasing knowledge about the association between facial appearance and personality as well as health is of great interest.

3. Approaches to capture Personality

Establishing a scientifically compelling taxonomy of personality has been a major goal in personality research (Goldberg, 1993). Researchers have sought to define and assess the concept of personality in its affective, temperamental, intrapsychic, characterological, and interpersonal domain (Gurtman, 2009; Mischel, 1968). This chapter focuses on two approaches to capture personality in terms of a general structural model: the interpersonal circumplex and the five-factor model. In addition, a third and more modern approach to personality, the Dark Triad, is elucidated.

3.1 Interpersonal Circumplex Framework

The interpersonal circumplex (IPC; Wiggins, 1979) is a widely used structural model of interpersonal traits based on two orthogonal dimensions: agency and communion. Agency, also referred to as dominance or status, means becoming individuated and represents the drive for power, competence, autonomy, and superiority. Communion, also known as nurturance, means becoming connected and represents the desire for social harmony, affiliation, and interconnectedness (Bakan, 1966; Gurtman, 2009; Leary, 1957; Wiggins, 1979). Due to their resemblance with evolutionary strategies of achieving status and maintaining social bonds, Wiggins (1991) proposed that agency and communion comprise the fundamental dimensions of interpersonal behavior. Empirical findings, showing that agency and communion are cross-cultural constructs (Abele, Uchronski, Suitner, & Wojciszke, 2008; Fiske, Cuddy, & Glick, 2007) and that people heuristically perceive others according to these dimensions (Abele, Cuddy, Judd, & Yzerbyt, 2008; Abele & Wojciszke, 2007), underline their universality and importance.

The interpersonal circumplex is a two-dimensional representation of agency and communion in which the combinations of these dimensions are organized as a circle - a continuous order without beginning or end (Horowitz, 2004; Kiesler, 1996; Wiggins, 1979). The IPC assumes that each interpersonal trait can be regarded as a particular blend of agency and communion, depending on the trait's location on the circle (Gurtman, 2009). Because the IPC has a circular structure, each trait's location is determined by its angular coordinates. Figure 1 illustrates an example of the IPC. The circumplex is comprised of a two-dimensional Cartesian coordinate system with four quadrants (Gurtman, 2009): Quadrant I (friendly-dominant), Quadrant II (hostile-dominant), Quadrant III (hostile-submissive), and Quadrant IV (friendly-submissive). The IPC comprises a continuous distribution of interpersonal traits around the circle, with no major gaps and no regions of greater or lesser density (Gurtman, 2009; Gurtman & Pincus, 2003). This circular structure distinguishes the IPC from traditional categorical models, such as the Big Five or the Dark Triad, which contain core categories of personality where traits tend to cluster. The IPC has played a leading role in how personality researchers have approached personality in the interpersonal domain (Gurtman, 2009). However, the IPC is limited to dispositions related to interpersonal behavior. The five-factor model presents a more

comprehensive approach, including affective, experiential, and motivational as well as interpersonal traits.

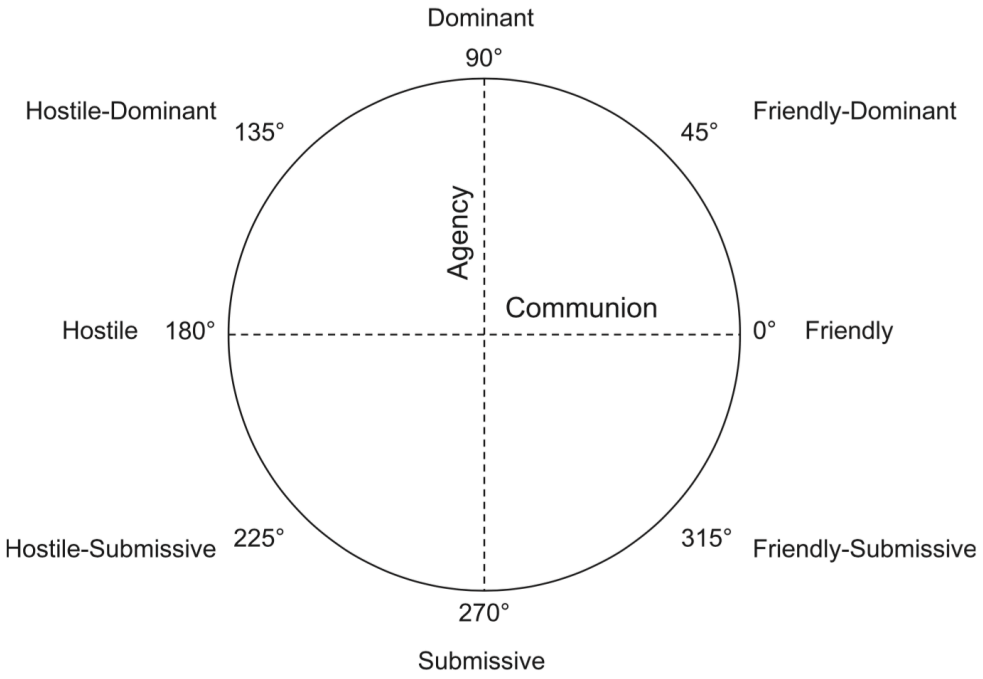

Figure 1. Interpersonal circumplex including dimensions, categories, and polar coordinates (Gurtman, 2009).

3.2 Five Factor Model of Personality

The five-factor model (FFM, Costa & McCrae, 1992; McCrae & Costa, 2013), also known as the Big Five, is the most researched and principal hierarchical taxonomy of personality traits. The FFM theorizes that traits are structured hierarchically and are organized within several broad dimensions of personality, each of them including a set of more specific lower-order traits. Within the FFM, interpersonal variations can be conceptualized into five broad trait dimensions that load onto orthogonal factors. The five dimensions of personality are neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Digman, 1990; De Raad & Perugini, 2002; Goldberg, 1990; John & Srivastava, 1999; McCrae & Costa, 2003). The neuroticism and extraversion dimensions are strongly linked to negative and positive emotionality, respectively (Watson & Clark, 1999; Markon, Krueger, & Watson, 2005). Neuroticism is considered as one of the personality traits most relevant to psychopathology, particularly to anxiety and depression (Kotov, Gamez, Schmidt, & Watson, 2010). Neuroticism comprises six dimensions: anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability (Costa & McCrae, 1992). According to Hogan (1986), extraversion consists of two components: ambition and sociability. Aspects of openness to experience are being imaginative, cultured, curious, broad-minded, intelligent, and artistically sensitive (Barrick & Mount, 1991). Agreeableness is primarily a dimension of interpersonal behavior and involves

characteristics such as trustworthiness, straightforwardness, altruism, compliance, modesty, and tender mindedness (Costa, McCrae, & Dye, 1991). Conscientiousness is ascribed to ego strength (Hartshorn, May, & Maller, 1929), will power, initiative, and responsibility (Murray & Kluckhohn, 1953). Costa and colleagues (1991) conceptualize conscientiousness as having both proactive (e.g. achievement and commitment) and inhibitive aspects (e.g. morality and cautiousness).

The FFM was discovered and preliminarily verified within psycho-lexical studies on the structure of personality (Goldberg, 1981, 1990), based on the assumption that all important personality dimensions are encoded in human's languages (Cattell, 1943; Goldberg, 1981; 1990). The FFM has received considerable empirical support and has proven its significance in assessing personality and predicting behavior in different areas of life (Digman, 1990; John & Srivastava, 1999; McCrae & Costa, 2003; Shaver & Brennan, 1992). Accordingly, the five factors represent not only descriptive personality traits but also dispositions or tendencies to individual patterns of thoughts, emotions, and behaviors (Strus, Cieciuch, & Rowiński, 2014). Empirical research has confirmed the comprehensiveness and universality of the FFM (Allik & McCrae, 2004; McCrae & Terracciano, 2005) as well as its biological foundations (Costa & McCrae, 1992; DeYoung & Gray, 2009; McCrae & Costa, 2003).

Whereas the FFM explains general dispositional tendencies that apply to most individuals and interpersonal situations, the Dark Triad focuses on less desirable personality traits that are pertain to more malevolent psychological propensities and behavioral strategies (Furnham, Richards, & Paulhus, 2013).

3.3 The Dark Triad of Personality

The Dark Triad represents a cluster of three personality traits: narcissism, Machiavellianism, and psychopathy (Paulhus & Williams, 2002). The concepts of these personality traits have their own historical roots and definitions (Muris, Merckelbach, Otgaar, & Meijer, 2017).

Narcissism originates from the Greek mythology, where Narcissus was so consumed by his own beauty and greatness that he despised the attention and love of others. This myth covers the core features of narcissism as the concept is used today, namely, a blend of vanity and egocentric admiration of one's own qualities, attention seeking, and exploitation that negatively affects social relationships (Campbell, Miller, & Buffardi, 2010). Although narcissism has been widely studied as a personality disorder, it has been conceptualized as a normal personality trait characterized by the ideals of dominance, exploitation, and feelings of superiority and entitlement (Raskin & Terry, 1988). The adaptation from a clinical to a subclinical construct has been empirically supported (Morf & Rhodewalt, 2001).

Machiavellianism emerged from a selection of statements from *Il Principe* (Machiavelli,1532/2004). In this book, the Italian diplomat and political theorist Niccoló Machiavelli advises kings and lords to establish and maintain their power through carefully planned and, if necessary, cruel and immoral strategies, such as the execution of political rivals (Muris et al., 2017).

Christie and Geis (1970) developed those statements into a measure of normal personality. Respondents who agreed with these statements were more likely to behave in a cold and manipulative manner (Christie & Geis, 1970). Those who score high on Machiavellianism tend to utilize deception and manipulation for personal gain (Jakobwitz & Egan, 2006).

Psychopathy finds its origins in psychiatry. Cleckley (1941) conducted systematic observations to characterize patients who exhibited enduring antisocial behavior, lack of empathy, and disinhibited behavior, concealed by superficial charm. The adaptation of psychopathy to a subclinical construct is the most recent (Hare, 1985; Lilienfeld & Andrews, 1996). Subclinical psychopathy fits into a pattern of high impulsivity, callous and remorseless manipulation, and thrill-seeking (Paulhus & Williams, 2002), and constitutes a psychological cause for antisocial and criminal behaviors (Hare, 1991).

Although the Dark Triad traits are of different origins, they have many characteristics in common. To a varying extent, all three traits contain a socially malevolent character with behavior tendencies toward self-promotion, callousness, duplicity, and aggressiveness (Jones & Paulhus, 2010; Paulhus & Williams, 2002). Low to moderate interrelations among narcissism, Machiavellianism, and psychopathy confirm their empirical overlap (Jakobwitz & Egan, 2006; Lee & Ashton, 2005; Paulhus & Williams, 2002). The Dark Triad of personality deals with these personality traits at a subclinical level that varies within the normal population. Even at subclinical levels, these three personality traits are linked to significant social, emotional, and legal harm (Furnham et al., 2013). Despite the harm they cause to others, these personality traits may confer crucial immediate and evolutionary benefits (Book, Visser, & Volk, 2015). For instance, all three Dark Triad traits appear to relate positively to short-term mating (Jonason, Li, & Buss, 2010). Therefore, Jonason, Webster, Schmitt, Li, and Crysel (2012) suggested the Dark Triad to be a fast and exploitative life history strategy that emphasizes gains at the expense of cooperation.

3.4 Summary

There are two established and widely used approaches to capture personality: the interpersonal circumplex and the five-factor model. Whereas the IPC captures personality two-dimensionally within a circular structure, the FFM assumes personality to have a hierarchical structure with five orthogonal factors. Both approaches have pointed out the value of their model for capturing the multidimensionality of personality. Nonetheless, the five-factor model in particular is non-sufficient in regard of socially malevolent personality traits. The third approach, the Dark Triad, closes this cap by encompassing three socially malevolent personality traits.

4. Multidimensional Conceptualization of Health

The most widely used modern definition of health originates from the World Health Organization: "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 2001, p. 1). Based on this definition, health is a multidimensional concept encompassing physical, mental, and social dimensions (Friedman & Kern, 2014).

4.1 Physical Health Dimension

Physical health is crucial for overall well-being and is the most visible of the different dimensions of health (Summers, 2012). Physical health can generally be differentiated into subjective versus objective health. Subjective health is assessed by self-reports, mostly by the Short-Form Health Survey (SF-36) questionnaire (Ware & Sherbourne, 1992). The SF-36 covers multiple components of health, including behavioral dysfunction, objective reports, subjective rating, and well-being. The four domains of physical health assessed by the SF-36 are: physical functioning (the ability to perform a variety of daily activities and tasks which require physical effort, such as climbing stairs), role limitations due to physical problems (the limitations a person has in performing work and other usual activities as a result of physical health problems), freedom from bodily pain (the self-reported bodily pain and discomfort), and vitality (the perceived level of energy and fatigue).

In contrast, objective health is an evaluation or evidence-based assessment by a health professional to determine either the general health, a specific disease risk, or the physical fitness. General health assessments include body mass index, waist to hip ratio, and reflex tests (Friedman & Kern, 2014). Common disease risk assessments are measures of the blood pressure, cholesterol, and blood glucose (Kaur, 2014). Physical fitness comprises a quantity of phenotypes, such as body composition, muscular strength, muscular endurance, flexibility, balance, and cardiopulmonary functioning (Frederiksen & Christensen, 2003). The most objective, reliable, and valid measure of physical health is longevity (Friedman & Kern, 2014). Life expectancy is thus one of the key elements of public health used worldwide (Mathers, 2002). Another important component of health is the quality of life which captures not only the quantity of years lived but also the years lived without significant impairment from disease or injury. Quality of life covers all three dimensions of health by covering physical well-being, emotional well-being, self-determination, personal development, material well-being, social relationships, social inclusion, and rights (Schalock & Siperstein, 1997).

4.2 Mental Health Dimension

Although various definitions of mental health exist, there is no general agreement on its conceptualization (Huppert & So, 2013). The WHO defines mental health as "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stress life, can work productively and fruitfully, and is able to make a contribution to his or her community" (WHO, 2004, p. 1). Mental health is seen as a multidimensional construct (Huppert & So, 2013) including subjective

well-being, perceived self-efficacy, autonomy, competence, intergenerational dependence, and self-actualization of the individual's intellectual and emotional potential (WHO, 2004). Mental health assessment has historically relied on subjective assessments, such as structured interviews or self-reports. The multi-purpose SF-36 is commonly used as self-report measure for assessing multiple dimensions of health. The mental health subscale of the SF-36 covers four major mental health dimensions: depression, anxiety, loss of behavioral or emotional control, and psychological well-being (Ware & Sherbourne, 1992). Objective measurements have a less prominent role in mental health assessment (Haberer, Trabin, & Klinkman, 2013), consisting of non-invasive (e.g. saliva samples to measure the adrenergic activity; Nater et al., 2006) and invasive methods (e.g. blood samples to measure serum drug level; Pasipanodya et al., 2013). Compared to subjective assessments, objective measures correlate higher with biological and clinical markers (Nieuwkerk & Oort, 2005; Simoni et al., 2006), but they may not directly be linked to mental health (Fletcher, Tam, Omojola, Redemske, & Kwan, 2011; Razavi, 2011).

Psychosocial resources and their beneficial impact on mental health have been highlighted by recent research (Ehlert, Gaab, & Heinrichs, 2001; Steptoe & Ayers, 2004). For instance, optimism and self-esteem have been suggested to be key resources in mental health functioning. The body of research related to optimism and self-esteem has become increasingly rich and various studies provided evidence for their association with subjective well-being (Achat, Kawachi, Spiro, DeMolles, & Sparrow, 2000; Karatas & Tagay, 2012; Manhas, 2014).

4.3 Social Health Dimension

The social determinants of health are the conditions in which people grow, live, work, and age (WHO, 2008). This section looks at three important components of social health, namely social relationships, social inclusion, and rights (Schalock & Siperstein, 1997).

Social relationships are crucial for subjective well-being and physical health (Cohen, Gottlieb, & Underwood, 2000; Holt-Lunstad, Smith, & Layton, 2010; House, Landis, & Umberson, 1988). Especially romantic relationships are evaluated as the primary source of intimacy, affection, and support (Levinger & Huston, 1990). Overall, the structure of social networks (Brissette, Cohen, & Seeman, 2000), social support (Cohen et al., 2000; Uchino, 2006), the quality and quantity of social interactions (Kiecolt-Glaser & Newton, 2001), relationship satisfaction (Fuller-Iglesias, 2015), and social isolation and loneliness (Cacioppo & Cacioppo, 2014; Steptoe, Shankar, Demakakos, & Wardle, 2013) have all been identified as predictors of health.

Social inclusion is defined as the extent to which individuals are able to participate in the social and economic life in an environment improving their well-being and individual potential (Walker & Wigfield, 2003). The concept of social inclusion covers socioeconomic security, social cohesion, and empowerment (Putnam, 2001), and refers to the democratic process of social quality, regardless of the cultural background (Huxley & Thornicroft, 2003). In particular, socioeconomic status seems to be one of the strongest and most persisting or even increasing predictor of a person's morbidity and

mortality (Nandi, Glymour, & Subramanian, 2014). Epidemiologic research has consistently shown that mortality risk increases as socioeconomic status decreases (Bond Huie, Krueger, Rogers, & Hummer, 2003; Lantz, Golberstein, House, & Morenoff, 2010; Turrell, Lynch, Leite, Raghunathan, & Kaplan, 2007). A worse general health status, increased number of comorbidities, lack of access to or underuse of health care services, and psychological factors may explain the associations of socioeconomic status with mortality risk (Laaksonen, Martikainen, Nihtilä, Rahkonen, & Lahelma, 2008; Stringhini et al., 2010; van Oort, van Lenthe, & Mackenbach, 2005).

Human rights refer to internationally recognized norms applying equally to all individuals worldwide. The right to health, defined as the right to the highest attainable standard of health, makes governments responsible for prevention, treatment, and control of diseases and the creation of conditions to ensure access to health facilities, goods, and services required for healthcare (Andorno, 2009; United Nations, 2008; UNESCO, 2009). Human rights are linked to health because they require governments not only to respect individual human rights and personal freedoms but also to protect people from harm by external sources and third parties, and to fulfil the health needs of the population (Grodin, Tarantola, Annas, & Gruskin, 2013).

4.4 Summary

Health is a multidimensional construct consisting of physical, mental, and social dimensions. It is not merely the absence of disease and illness, but rather a state of physical, mental, and social well-being. A healthy individual stands out by not only displaying physical functioning and fitness, but also by reporting subjective well-being and satisfying social relationships. The dimensions of health are strongly related and mutually influenced by important determinants, such as genetic vulnerability, health behavior, psychosocial resources, socioeconomic status, and health rights.

5. The Relationship between Facial Appearance and Personality

This chapter deals with inferences of personality based on facial appearance. When people encounter others for the first time, they make spontaneous inferences regarding their personality (Gilbert, Pelham, & Krull, 1988; Van Overwalle, Drenth, & Marsman, 1999). Due to its prominent and permanent display, facial appearance plays a key role in personality attribution and social perception (Little & Perrett, 2007; Willis & Todorov, 2006). Spontaneous trait inferences become an integral part of the representation of a person, rather than mere associations caused by the co-occurrence of faces and behaviors (Skowronski, Carlston, Mae, & Crawford, 1998). According to the ecological approach to person perception (Gibson, 1979), the function of spontaneous personality judgments is to provide adaptive information about a specific individual and ensuing to serve adaptive action (Zebrowitz & Montepare, 2006, 2008). In support of this adaptive value account are findings showing that personality inferences based on facial appearance reach high consensus both within and between cultures, thus suggesting that inferring personality from facial appearance is an evolved, universal, and adaptive ability (McArthur & Berry, 1987).

It is important to note that this thesis focuses exclusively on personality inferences from faces with neutral expressions. One important reason is that neutrality represents the "default" facial expression (McNeill, 2000). Yet another reason is that neutral faces exhibit emotional significance per se (Palermo & Rhodes, 2007). For instance, emotionally neutral male faces are perceived as threatening (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007) and dominant (Adams, Nelson, Soto, Hess, & Kleck, 2012). When people are not actively using their faces to express themselves, the social environment is not able to read their emotions, which leaves them in an uncertainty about their mind-state and behavioral intentions (Adams, Garrido, Albohn, Hess, & Kleck, 2016). To compensate for this uncertainty, static facial cues are used to gain first valuable information about the wearer of the neutral face. This face evaluation is important to serve adaptive social behaviors towards another person (Zebrowitz & Montepare, 2006, 2008). Consequently, facial appearance is assumed to play an even more important role in forming first impressions about a person with a neutral expression. Furthermore, the present thesis concentrates exclusively on studies using natural face photographs of individuals. Real faces differ more subtly in terms of personality traits; thus, they rather resemble real life situations involving the evaluation of an unknown person (Klapper, Dotsch, van Rooij, & Wigboldus, 2016). As this thesis focuses exclusively on photographs of real faces, it includes no research articles using artificial faces or composite images.

5.1 Personality Traits Attribution from Faces

This section starts with focusing on inferences of personality traits within the frame of the IPC and the FFM. Thereafter, inferences of other psychosocial traits are elucidated.

5.1.1 Interpersonal Circumplex Framework in Face Evaluation

People heuristically perceive others along the core dimensions of the IPC, namely agency and communion (Abele et al., 2008). In this respect, it is most likely that agency and communion underlie face evaluation as well. According to Oosterhof and Todorov (2008), face evaluation provides the basic information whether to approach or avoid a specific person. They mapped intuitive face evaluation onto a two-dimensional space defined by the basic dimensions of the IPC, agency and communion. According to their model, faces are automatically evaluated along these two dimensions (Todorov et al., 2008).

Their analysis revealed that evaluations of emotionally neutral faces are based on slight variations in the facial features. Communion inference seems to be evoked by facial features used for emotional expressions signaling approach or avoidance behaviors. The sensitivity of the communion evaluation to features resembling emotional expressions suggests that the trait inference of emotionally neutral faces is an overgeneralization of the perception of emotions (DeBruine, 2005; Montepare & Dobish, 2003). By contrast, agency seems to be deduced from facial cues conveying maturity and masculinity. Facial masculinity and maturity signal physical strength and its related ability to cause harm (Fiske et al., 2007). Therefore, the agency evaluation seems to be more sensitive to features signaling physical strength (Oosterhof & Todorov, 2008), thus referring to an overgeneralization of the perception of facial cues signaling the physical strength of a person.

Oosterhof and Todorov (2008) drew the conclusion that face evaluation is based on structural features that merely resemble cues with evolutionary significance. Functionally, the communion and agency related facial cues give rise to inferences about the person's intentions and the person's ability to implement these intentions, respectively.

5.1.2 Inferring Big Five Personality Traits from Faces

Studies using zero acquaintance paradigms, in which participants rate the personality of strangers, demonstrate a remarkably high inter-rater reliability (Borkenau & Liebler, 1992; Kenny, Horner, Kashy, & Chu, 1992). Moreover, the perceiver ratings correlate with the targets' self-reports on personality dimensions using the FFM, thus reflecting a high validity (Albright, Kenny, & Malloy, 1988; Hirschmüller, Egloff, Nestler, & Back, 2013; Kenny et al., 1992). While these findings demonstrate that trait attribution on zero acquaintance can be surprisingly accurate, few studies investigated the relationship between self-reports and face-based inferences of the Big Five personality.

In such studies, face photographs of the target persons are taken. The target persons complete a self-report personality questionnaire measuring the Big Five. The face photographs are then presented to independent perceivers who rate the target's personality on adjective scales. Borkenau and Liebler (1992) were the first to provide evidence that static face photographs are

sufficient for obtaining reliable and valid inferences of extraversion and conscientiousness. However, face-based perceptions and self-reported ratings of agreeableness showed a non-significant but positive relationship. The finding on the accuracy of inferring extraversion from facial appearance has been replicated (Penton-Voak, Pound, Little, and Perrett, 2006; Rule, Krendl, Ivcevic, & Ambady, 2013). Furthermore, accurate inferences of emotional stability and openness to experience for male faces were found (Penton-Voak et al., 2006). Borkenau, Brecke, Möttig, and Paelecke (2009) exposed assessors for either 150ms, 100ms, or 50ms to face photographs. Inter-rater reliability and validity were not systematically related to exposure time, but the validity differed strongly between traits, being highest for extraversion. Correspondingly, exposure to unknown faces for 50ms seems to be sufficient to infer their extraversion with significant accuracy.

Taken together, independent individuals make similar inferences of the Big Five when presented with a face photograph. Interestingly, these judgments may accurately reflect "real" personality. Extraversion seems to be the personality dimension that is most accurately inferred from facial appearance.

5.1.3 Psychosocial Correlates of Facial Appearance

This section focuses on psychosocial trait inferences from facial appearance. First, inferences of two highly-investigated traits, dominance and trustworthiness, are emphasized. Relating to the IPC, dominance can be referred to agency, whereas trustworthiness belongs rather to communion (Oosterhof & Todorov, 2008; Rule & Ambady, 2011; Todorov et al., 2008). In addition, other psychosocial trait inferences from facial appearance, namely intelligence, criminality, suicidality, and sociosexual orientation, are reported.

Keating, Mazur, and Segall (1981) were the first to demonstrate a high inter-rater reliability in inferring dominance from face photographs. They adopted a physiognomic approach by selecting specific facial features used for dominance attribution. Modern research has confirmed the reliable inference of dominance and trustworthiness from faces (Bar et al., 2006; Oosterhof and Todorov, 2008; Todorov et al., 2008; Willis & Todorov, 2006). A minimal exposure of 100ms is sufficient to reliably infer competence, trustworthiness, likeability, attractiveness, and aggressiveness (Willis & Todorov, 2006) as well as threat (Bar et al., 2006) from an unknown face. Oosterhof and Todorov (2008) applied the two-dimensional model of face evaluation and showed that individuals strongly agree in their trait inferences of trustworthiness, dominance, and threat. With regard to the predictive validity of such inferences, perceptions of dominance based on the facial appearance of graduates predicted their final military rank attainment (Mazur, Mazur, & Keating, 1984) and perceived facial competence predicted the outcome of elections (Ballew & Todorov, 2007; Todorov et al., 2005). Inferences of power encompassing competence, dominance, and maturity drawn from law firm managers' faces significantly correlated with the profits that the firms earned (Rule & Ambady, 2011). For trustworthiness, there is growing evidence for spontaneous and relatively stable face-based inferences (Klapper et al., 2016; Marzi, Righi, Ottonello, Cincotta, & Viggiano, 2014). However, studies investigating the validity of trustworthiness inferences from facial appearance provided

inconsistent results. Porter, England, Juodis, ten Brinke, and Wilson (2008) examined the accuracy of trustworthiness inferences of two groups (untrustworthy vs. trustworthy faces). Judgments for trustworthy faces were more accurate and consistent than judgments for untrustworthy faces. Participants were able to use face-based judgments of kindness but not aggressiveness to successfully discriminate the two groups. Therefore, the researchers suggested that individuals use rather a "friend?" strategy, but neglect to use the "foe?" strategy for detecting trustworthiness in faces. Rule and colleagues (2013) investigated the validity of trustworthiness judgments and could not find any relationship between face-based inferences and objective measures of trustworthiness. By contrast, Slepian and Ames (2016) found that face-based inferences predicted the trustworthiness of targets' behavior. However, this high validity of face evaluation was mainly generated by a self-fulfilling prophecy (Zebrowitz, 1999). The targets' expectations of how other people would perceive them and their intentions to act in accordance with those expectations were responsible for the effects.

In terms of intelligence, the research literature is inconsistent about the accuracy of inferences from facial appearance. In one study, inferences were more accurate than chance in childhood and adolescence, marginally more accurate in middle adulthood, and lost their accuracy in late adulthood (Zebrowitz, Hall, Murphy, & Rhodes, 2002). In another study, intelligence appeared to be legible from students' faces. Face-based inferences of intelligence corresponded to the actual performance in a math and verbal test (Rule et al., 2013). Lastly, Kleisner, Chvátalová, and Flegr (2014) showed that perceived facial intelligence is associated with measured intelligence in men only.

Inferences of criminality from facial appearance have captured the researchers' attention since the 19th century (Lombroso, 1876). Perceived facial criminality has been found to be strongly related to facial cues of threat, but these traits only partially overlap (Flowe, 2012). Facial maturity (Dumas & Testé, 2006) and facial masculinity (Ward, Flowe, and Humphries, 2012) were associated with a criminal appearance. Klatt and colleagues (2016) found evidence that participants spontaneously make criminal appearance attributions. These inferences persisted with repeated presentation and increased exposure duration, were associated with perceived facial trustworthiness and dominance, and were made with a high degree of certainty. With regard to the accuracy of criminality inferences from facial appearance, Valla, Ceci, and Williams (2011) found that participants are able to distinguish between criminals and non-criminals based solely on neutral face photographs, controlling for ethnicity, age, facial hair, and markings or any other indicators of criminal status. However, participants were unable to accurately infer more nuanced distinctions of criminality, namely the violent/non-violent status, and the crime committed.

Kleiman and Rule (2012) showed that individuals can accurately perceive suicidality from facial appearance. Individuals who had committed suicide were perceived as more impulsive than living controls. No group differences were found with respect to perceptions of depression, life satisfaction, and hopelessness. Consequently, the distinction between the faces of suicidal victims and living controls was not based on affect-related variables. The researchers indicated a limited legibility of affective states from facial appearance. Nonetheless, facial appearance may hold cues to

suicidality; thus, providing new insights into the relationship between mental health and facial appearance.

Boothroyd, Jones, Burt, DeBruine, and Perrett (2008) sought to examine the accuracy of perceivers' inferences of sociosexual orientation from faces. They found that perceivers are generally able to distinguish between individuals on the basis of sociosexuality. Specifically, participants were able to identify individuals who are more likely to be interested in short- or long-term relationships. In terms of sexual orientation, Rule and Ambady (2008) showed that the male sexual orientation can accurately be inferred from facial appearance. However, the researchers were not able to explain the ability to infer sexual orientation from faces. A recent study has given more insight by showing that men's faces differ according to their sexual orientation along the facial structure and a variety of facial cues (Skorska, Geniole, Vrysen, McCormick, and Bogaert, 2015).

Overall, the research on personality inferences from faces predominantly has reproduced the same finding, thus tending to confirm that certain aspects of personality can be discerned from facial appearance. Although the correlations are small to moderate (*r* between 0.20 and 0.30; e.g. Rule & Ambady, 2011; Slepian & Ames, 2016), they are significant and support the "kernel of truth" hypothesis (Berry & Finch Wero, 1993). A hormonal mechanism is assumed to be responsible for this "kernel of truth" due to a common biological cause for the development of both personality and facial appearance.

5.2 Sexual Differentiation as Biological Link between Facial Appearance and Personality

The relationship between facial appearance and personality traits may be mediated by a common hormonal mechanism affecting both (Re & Rule, 2015). Gonadal hormones play a key role in the differentiation of male and female phenotypes throughout the course of human development (Hines, 2011). The differential effect of testosterone and estrogen in males and females throughout the life-span is responsible for the sexual dimorphism apparent in the facial appearance. Estrogen, the primary female sex hormone, promotes the development of feminine facial features by inhibiting the effects of testosterone (Rhodes, 2006). Testosterone, the primary male sex hormone, is largely responsible for masculinization in adolescence (August, Kaplan, & Grumbach, 1972).

Previous research provided evidence for the effect of pubertal testosterone exposure on the contemporaneous increased facial masculinity. For instance, a positive association between baseline testosterone and male-typical facial characteristics in adolescents was found (Marečková´et al., 2011). Furthermore, the administration of testosterone to adolescents with delayed puberty accelerated their craniofacial growth (Verdonck, Gaethofs, Carels, & de Zegher, 1999). Facial masculinity may develop due to organizational effects of testosterone during fetal development that are activated by elevated secretion of testosterone during adolescence (Whitehouse et al., 2015). A 20-year follow-up study provided first empirical evidence of a link between prenatal testosterone exposure and facial masculinity (Whitehouse et al., 2015). Testosterone concentrations were

measured from the umbilical cord blood of newborns and facial photographs of these participants in adulthood were procured. Higher cord but not adult baseline testosterone levels were associated with masculinized facial features. In contrast, other studies found a positive association between adult baseline testosterone and perceived facial masculinity (Penton-Voak, & Chen, 2004; Roney, Hanson, Durante, & Maestripieri, 2006) as well as more objective measurements, such as increased fWHR (Lefevre et al., 2013). In another study, reactive but not baseline testosterone in adulthood was positively associated with facial masculinity (Pound, Penton-Voak, & Surridge, 2009).

Despite inconsistencies, the studies demonstrate altogether that facial masculinity is associated with testosterone which affects both the facial development and the expression of behavioral traits as part of sexual differentiation in adolescence. Testosterone has been linked to aggression (Archer, 2006), sensation seeking (Roberti, 2004), and dominance (Carré, Putnam, & McCormick, 2009; Josephs, Newman, Brown, & Beer, 2003; Mazur & Booth, 1998). Due to the common relations with both facial appearance and behavioral traits, testosterone has been proposed as a common underlying factor linking facial appearance to personality (Lefevre et al., 2013; Swaddle & Reierson, 2002).

One particular configurational facial feature characterizing the face shape and masculinity of male faces is the facial width-to-height ratio which has been linked to testosterone and dominance.

5.3 Facial Width-to-Height Ratio and Personality

The facial width-to-height ratio (fWHR) has received much attention because of its association with social dominance in men. This section first describes the definition and measurement of the fWHR. The section then elucidates the link of fWHR to various facets of social dominance. Finally, potential factors influencing the link between fWHR and dominance are discussed.

5.3.1 Definition and Measurement of the Facial Width-to-Height Ratio

Facial width-to-height is an anthropometric measure of face shape (Weston et al., 2007). The fWHR is calculated by dividing the bizygomatic width of the face by the upper-face height. The bizygomatic width is defined as the horizontal distance between the left and right zygions. The upper-face height refers to the vertical distance from the highest point of the upper lip to the highest point of the eyelids (Stirrat & Perret, 2010).

The standard method of assessing the fWHR is to take standardized frontal face photographs with a digital camera on a tripod while the participant is standing upright in front of a white background under standardized lighting. While being photographed at a standardized camera distance and angle, the participant is instructed to maintain a neutral facial expression. Prior to the measurement of the fWHR, the face photographs are rotated to achieve a horizontal alignment of the pupils (Carré & McCormick, 2008; Lefevre et al., 2013; Stirrat & Perret, 2010). Figure 2 illustrates an example how the fWHR is measured from face photographs using the National Institutes of Health open-access ImageJ software (Schneider, Rasband, & Eliceiri, 2012).

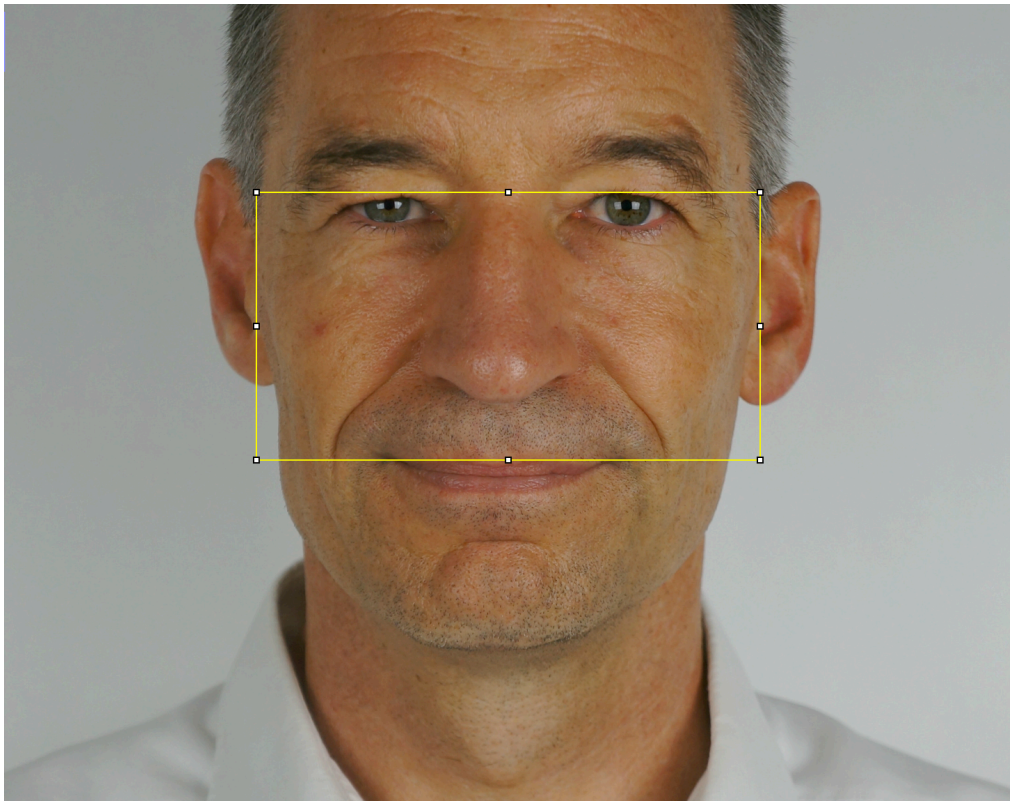

Figure 2. An example illustrating how fWHR is measured from frontal face photographs. Images are rotated so that the pupils are horizontally aligned. Bizygomatic width is measured as the horizontal distance between the left and right zygions, and upper-face height as the vertical distance between the highest point of the upper lip and the highest point of the eyelids. The fWHR is calculated as width divided by height.

5.3.2 Facial Width-to-Height Ratio as a Biomarker for Dominance

This section sheds light on the link between fWHR and social dominance in men. Most of the studies investigated fWHR and its link to aggression but also other behavioral traits such as deceptive and competitive behavior. The aforementioned behavioral traits can be encompassed by the overarching trait of dominance (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013).

Carré and McCormick (2008) provided the first empirical evidence that fWHR predicts aggressive behavior in men. Consequently, the authors suggested fWHR to be an honest signal of the propensity for aggressive behavior. In a subsequent study, the researchers showed that participants reliably perceive men with greater fWHRs as more aggressive and more dominant than men with smaller fWHRs (Carrè, McCormick, & Mondloch, 2009). The authors concluded that fWHR may be one of the facial cues used to make accurate estimates of aggression. Further studies confirmed the link between fWHR and aggression by showing that fWHR is strongly linked to both perceptions of aggressiveness (Geniole, Keyes, Mondloch, Carré, & McCormick, 2012; Geniole, Molnar, Carré, & McCormick, 2014; Třebický et al., 2015) and self-reports of dominance and aggression (Lefevre, Etchells, Howell, Clark, & Penton-Voak, 2014). Moreover, fWHR influences both the face-based inferences and the actual aggression (Bosyan, Zebrowitz, Franklin, McCormick, &

Carré, 2013). The link between fWHR and perceived facial aggressiveness appears to be affected by neither facial hair (Geniole & McCormick, 2015) nor ethnicity (Short et al., 2012). However, other research failed to replicate the link between fWHR and aggression by showing that body weight, but not fWHR, predicts aggression in a sample of professional hockey players (Deaner, Goetz, Shattuck, & Schnotala, 2012). Furthermore, a study using a sample of prisoners demonstrated that fWHR is not significantly greater in those males subjected to prosecution decisions involving crimes of interpersonal aggression (Gomez-Valdés et al., 2013).

Besides aggression, deception seems to be another behavioral trait linked to fWHR. Men with greater fWHRs were perceived as untrustworthy and were more likely to exploit the trust others than men with smaller fWHRs (Stirrat & Perret, 2010). Furthermore, men with greater fWHRs were at higher risk to explicitly deceive their counterparts in a negotiation, and were more willing to cheat with the objective of financial gain. The link between fWHR and this unethical behavior was mediated by a subjective sense of power. Men with greater fWHRs felt more powerful and this sense of power directly impacted their ethical behavior (Haselhuhn & Wong, 2011). The link between deceptive behavior and fWHR has also been observed in real business life: firms with chief executive officers (CEOs) with greater fWHRs had a higher incidence of financial misreporting, opportunistic insider trading, and option backdating (Jia, Van Lent, & Zeng, 2014). As deceptive and criminal behavior represents a characteristic of psychopathy, two studies examined specifically the link between fWHR and this personality trait. Geniole, Keyes, Carré, & McCormick (2014) showed that fWHR is not only associated with willingness and extent to cheat but also with the psychopathic personality trait fearless dominance. Anderl and colleagues (2016) replicated and extended this finding by demonstrating that fWHR is positively linked to fearless dominance but also to self-centered impulsivity and overall psychopathy scores.

With regard to competitive behavior, Stirrat and Perret (2012) showed that men with greater fWHRs display more self-sacrificing cooperation to help their own group members in a competition with another group. Interestingly, participants were also more likely to select men with greater fWHRs for group membership during intergroup competition (Hehman, Leitner, Deegan, & Gaertner, 2015). During a negotiation, men with greater fWHRs were less cooperative compared to men with smaller faces, allowing them to claim more value when negotiating with their counterparts (Haselhuhn, Wong, Ormiston, Inesi, & Galinsky, 2014). The relationship between fWHR and competitive behavior can also be observed in the worlds of business and sports: the fWHR of CEOs predicted their firms' financial performances (Wong, Ormiston, and Haselhuhn, 2011). Similarly, Alrajih and Ward (2014) showed that CEOs of the leading UK businesses have greater fWHRs than age- and sex-matched controls. Moreover, perceivers rated the faces of the CEO's as higher in dominance and success and these ratings correlated with the fWHR. Interestingly, the fWHR was also positively associated with achievement motivation in US presidents (Lewis, Lefevre, & Bates, 2012). With regard to sports, fWHR was associated with fighting performance and perceived facial aggressiveness in martial arts combatants, independent of body size (Třebický et al., 2015; Zilioli et al., 2015). fWHR was also linked to baseball performance in professional baseball players (Tsujimura & Banissy, 2013). Finally,

Welker, Goetz, Galicia, Liphardt, and Carré (2015) examined the relationship between fWHR and performance among soccer players participating in the 2010 World Cup. Across all 32 countries involved, fWHR was positively related to fouls committed and goals scored.

Regarding the construct of dominance in general, fWHR was positively associated with dominance, self-reported (Valentine, Li, Penke, & Perrett, 2014) as well as perceived from others (Mileva et al., 2014). fWHR was also indicative of physical strength (Holzleitner & Perret, 2016; Sell et al., 2009) and men with greater fWHRs appeared less likely to die from contact violence (Stirrat, Stulp, & Pollet, 2012).

Some of the abovementioned studies are included in two recent meta-analyses investigating the link between fWHR and different aspects of dominance. First, Haselhuhn, Ormiston, and Wong (2015) indicated a robust positive, but small, link between fWHR and aggression (r = .11), thus suggesting that fWHR is a reliable biomarker of aggression in men. Second, Geniole, Denson, Dixson, Carré, and McCormick (2015) demonstrated that fWHR is associated with both threat and dominant behavior (r = .16 and r = .12, respectively), success in business-related outcomes (r = .32), sports performance (r = .15), and perceptions of threat and dominance (r = .46).

Taken together, there is empirical evidence showing that men with greater fWHRs exhibit more dominant behavior and are also perceived as more dominant by naive raters than men with smaller fWHRs, thereby suggesting that this metric of face shape is associated with different dimensions of dominance.

5.3.3 Factors influencing the Link between Facial Width-to-Height Ratio and Dominance

This section focuses on potential factors influencing the link between fWHR and dominance. As underlined in the previous section, most of the studies provided evidence for the link between fWHR and aggression (Haselhuhn et al., 2015). However, some research could not replicate the link between fWHR and aggression (Deaner et al., 2012; Gomez-Valdés et al., 2013). The reasons for these inconsistencies are still unclear. Given the convergence of research literature linking fWHR significantly with aggression, it seems highly unlikely that all of these findings represent Type 1 error. Rather, specific bio-psychosocial factors are suggested to be responsible for the variable association between fWHR and dominance.

Goetz and colleagues (2013) proposed social status as one important factor moderating the association between fWHR and aggression. In general, low status individuals are more likely to engage in aggressive behavior than high status individuals. For instance, the majority of homicides is committed by men of relatively low social status (Wilson, Daly, & Pound, 2009). The authors explained this effect of social status by means of different consequences of a criminal record. Those with the highest social status are not protected from the deleterious consequences of a committed crime, but instead experience the greatest declines in social status due to a criminal record (Dennison & Demuth, 2017). By contrast, low-status men have relatively little to lose from aggressive behavior (Wilson et al., 2009). This effect of social status can be reconciled with the statement: "The more you

have, the more you lose; the less you have, the less you lose". Consequently, Goetz and colleagues (2013) suggested particularly low-status men with greater fWHRs to exhibit aggressive behavior. First, because they face less adverse consequences in terms of reductions in social status due to their aggressive behavior in comparison to high-status men; second, because they are physically stronger (Holzleitner & Perret, 2016; Sell et al., 2009) and die less likely from violence (Stirrat et al., 2012) compared to men with smaller fWHRs. Goetz and colleagues (2013) pursued to examine their hypothesis and the influence of social status on the association between fWHR and aggression. In their first study, fWHR was positively associated with aggressive behavior, but only among college students reporting relatively low social status. This effect was replicated in a sample of professional hockey players. They found that fWHR was positively related to aggressive behavior, but only among players who earned relatively low salaries. Taken together, their studies provided the first evidence for the role of social status in influencing the relationship between fWHR and aggression. Welker, Goetz, and Carré (2015) extended this finding by showing that the current and experimentally manipulated status moderates the relationship between fWHR and risk-taking behavior. fWHR was positively associated with risk-taking, but only when the subjective social status was low. Next, the social status was manipulated in a video game (defined as losing vs. winning the game). fWHR predicted risk-taking only in the loss condition. Men with both low subjective status as well as low manipulated social status (being in the loss condition) exhibited the strongest relationship between fWHR and risk-taking. Based on these findings, Welker and colleagues (2015) indicated that fWHR is not per se an indicator of risk-taking and dominance, but only when individuals perceive themselves as being low in status. fWHR may exclusively promote risk-taking in specific circumstances where it is advantageous, such as the circumstance of a low social status.

Testosterone may be another important factor influencing the link between fWHR and dominance. The androgen has been proposed as a common underlying factor linking fWHR to dominance-related behavioral traits by affecting both the craniofacial growth and the expression of behavioral traits as part of sexual differentiation in adolescence (Carré & McCormick, 2008). Supporting this link, baseline and testosterone reactivity were positively linked to fWHR (Lefevre et al., 2013), and baseline testosterone was positively related to self-reported dominance (Carré et al., 2009) and aggression (Archer, 2006). However, fWHR in adult men was associated with neither variation in androgens during adolescence (Hodges-Simeon, Sobraske, Samore, Gurven, & Gaulin, 2016) nor with fetal androgens (Whitehouse et al., 2015). Moreover, a recent analysis indicated no evidence of a significant relationship between fWHR and baseline testosterone (Bird et al., 2016). However, it is noteworthy that the authors limited the significance of their analysis insofar as their finding might be attributable to not taking into account relevant co-variables such as body mass index (BMI). Previous research has noted a positive association between BMI and fWHR (r = .31, Geniole et al., 2015) and a negative association between BMI and testosterone (r = -.31, Shamim, Ali Khan, & Arshad, 2015), suggesting that BMI may mask certain effects.

In summary, potential influencing factors should be incorporated when investigating the link between fWHR and dominance. In particular, social status and testosterone have been considered as

important factors. Social status has been shown to be an important moderator in the relation between fWHR and aggressive behavior as well as risk-taking. Testosterone seems to be an important mechanism linking fWHR to dominance-related traits, but the effects of adult testosterone remain unclear.

5.4 The Risk of Overgeneralizing Personality Attribution from Faces

The studies discussed in this chapter point mostly to the same finding that aspects of personality can be inferred from facial appearance. These trait inferences are formed almost immediately, intuitively, and often without reflection or conscious awareness (Hassin & Trope, 2000; Kahnemann, 2003; Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006). Inferring traits from facial appearance is a robust and automatic process; thus, indicating that face-based inferences can have pervasive consequences in daily life. For instance, trustworthiness inferences occur even in tasks in which trustworthiness of displayed faces is irrelevant (Engell, Haxby, & Todorov, 2007; Mende-Siedlecki, Said, & Todorov, 2012). And, although behavioral information is available, people still rely on how trustworthy the face looks for their decisions of how much to trust another person (Rezlescu, Duchaine, Olivola, & Chater, 2012; Rudoy & Paller, 2009; van't Wout & Sanfey, 2008). The strong influence of facial appearance on people's judgments can have deleterious consequences. For instance, Wilson and Rule (2015) found that legal authorities overgeneralized facial trustworthiness past judicially relevant behavioral information to disproportionately sentence targets who looked untrustworthy to execution. The overgeneralization persisted even after viewing innocent people who had been exonerated after originally being sentenced to death. These findings highlight the power of facial appearance to prejudice perceivers, possibly with deleterious life outcomes.

The robustness of face evaluation can be explained by an evolutionary point of view. Accurate and immediate face evaluation is crucial for both survival and successful social interaction (Bar et al., 2006; Ghanzafar & Santos, 2004). Therefore, trait inferences are merely based on facial cues with evolutionary importance (Zebrowitz, 2004). As mentioned beforehand in section 5.1.1, Oosterhof and Todorov (2008) theorized that face evaluation may be the consequence of overgeneralizing adaptive mechanisms for inferring harmful intentions and the ability to cause harm. In other words, face evaluation helps to distinguish between friend or foe. The overgeneralization hypothesis can explain that the automatic face evaluation is essential for survival, however, it does not necessarily yield veridical inferences. Nonetheless, previous findings predominantly demonstrate the inter-rater reliability and predictive validity of such face-based evaluations. In terms of trustworthiness, an accuracy rate of 62.7% compared with a 50% accuracy rate in the case of random guessing was found (Porter et al., 2008).

Taken together, personality judgments are based on facial features resembling cues with evolutionary significance. Therefore, accurate face evaluation is crucial for successful social

interaction. However, it is important to be aware of potential perception biases and the impact of face evaluation on important life outcomes.

5.5 Summary

Certain personality traits, such as dominance or trustworthiness, can be indeed inferred from facial appearance. This link between facial appearance and personality can be explained by a common hormonal mechanism influencing both. Recent research has focused on face shape, specifically the fWHR, and its link to aggression and other dominance-related behavioral traits. New findings indicate that bio-psychosocial factors can influence the link between fWHR and dominance. In particular, social status seems to be an important moderator. Future research is encouraged to further examine potential factors influencing the link between fWHR and social dominance.

6. The Relationship between Facial Appearance and Health

This chapter focuses on the assessment of health based on facial appearance. Impressions of health are a daily occurrence and integral to social interactions, yet poorly understood. Understanding on what facial cues these judgements are based on is important because they are consequential in terms of real-world outcomes such as dating and or employment outcomes. Moreover, health inferences can have detrimental social consequences due to the evolutionary advantage of maintaining a physical distance from those who look unhealthy in order to avoid contagious disease (Henderson, Holzleitner, Talamas, & Perrett, 2016). Indeed, when confronted with images of diseases, people evaluate themselves as less extraverted and withdraw in response to faces (Mortensen et al., 2010). Consequently, negative judgements of perceived health may lead to a risk of social isolation and stigmatization (Park et al., 2007; Duncan & Schaller, 2009).

6.1 Health Assessment from Faces

How attractive and how old the face looks are two key factors in determining the health of a particular person. This chapter focuses first on facial attractiveness and its association with health. Thereafter, perceived age is defined and its potential of being a valid biomarker for healthy aging is discussed.

6.2 Facial Attractiveness and Health

Facial attractiveness has been studied extensively, particularly in the context of biologically-based preferences. Consistently, facial attractiveness and attractive-related traits have been associated with mate choice and mating success (Thornhill & Gangestad, 1999; Rhodes, 2006; Little, Jones, & DeBruine, 2011). People use attractive cues when evaluating faces from photographs as either potential dates or long-term relationship partners (Buss, 1989; Tskhay, Clout, & Rule, 2017).

From an evolutionary point of view, facial attractiveness serves as a cue of mate quality and reproductive value (Gangestad & Scheyd, 2005; Hume & Montgomerie, 2001; Rhodes, 2006; Rhodes, Simmons, & Peters, 2005; Thornhill & Gangestad, 1999). Evolutionary theories propose that preferences for certain facial characteristics evolved because those characteristics provide signals of biological quality, particularly physical health (Andersson, 1994). Based on the idea of facial attractiveness being an honest indicator of health and genetic quality, facial attractiveness should play an important role in social interactions (Barber, 1995; Buss & Schmitt, 1993; Daly & Wilson, 1999; Symons, 1979; Thornhill & Gangestad, 1993) and should be consistently detected and recognized within and across cultures. Indeed, studies provided evidence for a universal appreciation of attractiveness (Berry, 2000; Kalick, Zebrowitz, Langlois, & Johnson, 1998). Attractive people are consistently stereotyped as both healthy and successful, and are treated more favorably than unattractive individuals, even from those they are familiar with (Langlois et al., 2000).

Two evolutionary theories provide plausible explanations for this "beautiful is good" stereotype. The good-genes theory of sexual selection predicts facial attractiveness to be strongly

associated with traits linked to survival, such as health, intelligence, or other measures of competence. Furthermore, as attractiveness advertises health and quality, the theory expects attractive people to be better judged and treated compared with unattractive people. Finally, because health is crucial for survival, attractiveness should be equally essential in both sexes (Keller, Thiessen, & Young, 1996; Thornhill & Gangestad, 1993). Likewise, the mate selection theory predicts that initially unrelated traits co-evolve because of concurrent selection and cross-trait assortative mating (Buss, 1985; Hansen, 2006). Consequently, traits crucial for survival or reproductive success should be closely linked. Langlois and colleagues (2000) examined the two theories in a meta-analysis. They found no sex differences in the importance of facial attractiveness. In agreement with both theories, traits linked to quality and survival, particularly occupational success, physical health, popularity, dating experience, and sexual experience, were strongly associated with facial attractiveness. However, relatively small effect sizes occurred for mental health and social skills and no relationship emerged for intelligence and facial attractiveness. The missing phenotypic link between intelligence and facial attractiveness was replicated in a co-twin study (Mitchem et al., 2015). Further research supports the idea that facially attractive people are not only perceived as healthier but that they have in fact a better physical health. For instance, ratings of facial attractiveness predicted future longevity (Henderson & Anglin, 2003) and were associated with semen quality (Soler et al., 2003). Furthermore, facial attractiveness was directly linked to a measure of genetic quality and immune function (Roberts et al., 2005).

Taken together, previous studies pointed out a link between facial attractiveness and health as well as reproductive fitness. The majority of studies, however, used specific components of facial attractiveness. In particular, masculinity, averageness, symmetry, adiposity, and skin color have been identified as potential candidates for biologically-based preferences (Rhodes, 2006; Little et al., 2011).

6.2.1 Masculinity

Masculine facial features develop during adolescence under the influence of testosterone which has been suggested to have immunosuppressive effects (Kanda, Tsuchida, & Tamaki, 1996; Yesilova et al., 2000). Accordingly, the immunocompetence handicap hypothesis states that masculinity indirectly indicates genotypic quality by signaling the ability to resist the immunosuppressive effects of testosterone (Folstad & Karter, 1992). Consequently, masculinity implies better innate immunity and health and should therefore be evaluated as attractive (Hamilton & Zuk, 1982). In line with the handicap hypothesis, the phenotype-linked fertility hypothesis proposes that male secondary sexual traits are attractive because they provide information about male fertility (Sheldon, 1994). However, besides being a cue to heritable genetic benefits, masculinity is also linked to undesirable behavioral personality traits (e.g. Perrett et al., 1998). Women seem to prefer masculine male faces when genetic quality may take priority over desirable personality traits. For example, women prefer men with masculine faces when they aim at having a short-term but not a long-term relationship (Little, Cohen, Jones, & Belsky, 2007) and when they are in the most fertile period of their menstrual cycle

(Ditzen, Palm-Fischbacher, Grossweiler, Stucky, & Ehlert, 2017). Taken together, the preference for masculinity seems to depend on contextual and individual factors.

Regarding the link between masculinity and health, several studies found a positive association between facial masculinity and ratings of perceived health (Boothroyd, Scott, Gray, Coombes, & Pound, 2013; Rhodes, Chan, Zebrowitz, & Simmons, 2003, Rhodes et al., 2007; Scott, Pound, Stephen, Clark, & Penton-Voak, 2010). However, studies investigating whether masculinity is indeed related to objective health are inconclusive. In the first study investigating the link between masculinity and health, perceived facial masculinity was associated with general health measures as a composite score from adolescent medical records, although the masculine faces were not perceived as attractive (Rhodes et al., 2003). Subsequent studies showed that facial masculinity is negatively related to the self-reported number of prior colds and flu (Boothroyd et al., 2013; Thornhill & Gangestad, 2006). Furthermore, facial masculinity was positively related to attractiveness and negatively linked to oxidative stress (Gangestad, Merriman, & Thompson, 2010). However, using a hepatitis B vaccination protocol, Rantala and colleagues (2013) reported that masculinity was related to neither facial attractiveness nor antibody response. Thus, suggesting that facial masculinity is not a cue to immunocompetence when judging the attractiveness of men.

Taken together, only a few studies found a relationship between masculinity and objective health. Facial masculinity may play a larger role in intra-sexual competition, and preferences for masculinity may arise from desiring competitive men rather than apparent immunocompetence.

6.2.2 Symmetry and Averageness

Symmetrical and average faces are perceived as more attractive than asymmetric or distinct faces (Rhodes et al., 2001; Lie, Rhodes, & Simmons, 2008; Penton-Voak et al., 2001; Scheib, Gangestad, & Thornhill, 1999).

Facial symmetry defines the degree to which one-half of a face is the same as the other half. Symmetry reflects an individual's ability to overcome adverse genetic and environmental effects during development, thus serving as a cue to developmental stability (Møller, 1999). By contrast, developmental instability occurs when the organism is unable to buffer its development against random perturbations (van Dongen & Gangestad, 2011). The most common marker of developmental instability used in research is fluctuating asymmetry which reflects random deviations from symmetry on bilateral facial features, that are, on average, symmetric at the population level (Møller, 1999; Thornhill & Gangestad, 1996). Differences between the two sides reflect minor developmental errors or perturbations affecting only one side of the facial feature (Klingenberg, 2003; Van Dongen, 2006). Rhodes and colleagues (2001) showed that the association between fluctuating asymmetry and health is limited only to perceived facial health. Other studies showed that fluctuating asymmetry is negatively associated with subjective well-being (Shackelford & Larsen, 1997) and positively linked to self-reported respiratory illnesses (Thornhill & Gangestad, 2006). However, several studies failed to find relationships between facial asymmetry and actual health (Hume & Montgomery, 2001; Rhodes et al., 2001; Pound et al., 2014; Tomkinson & Olds, 2000). Two meta-analyses found a weak but

robust positive effect for fluctuating asymmetry to be an indicator of health (Švegar, 2016; Van Dongen and Gangestad, 2011).

Averageness corresponds to how closely a face resembles the majority of other faces within a population. Facial averageness constitutes a marker of phenotypic and genotypic quality (Little et al., 2011; Rhodes, 2006; Thornhill & Gangestad, 1999). Average faces indicate an individual's heterozygosity and greater genetic diversity, and associated therewith, immunocompetence and disease resistance (Gangestad, Simpson, DiGeronimo, & Biek, 1992). Despite the theoretical link between averageness and health, research literature examining this link is scarce. Marked deviations from facial averageness occur in chromosomal disorders (Thornhill & Møller, 1997). Averageness from adolescent faces was associated with ratings of perceived health and actual health in childhood (Rhodes et al., 2001). Lie and colleagues (2008) provided evidence that facial averageness is directly linked to heterozygosity in the major histocompatibility complex, a measure of genetic quality and immune function.

Taken together, facial asymmetry and averageness seem to reflect developmental stability. However, their association with health is mostly limited to perceptions of health. Accordingly, Rhodes (2006) suggested the link between these facial features and health to be much weaker than in more ancient times due to the advancements of medical science.

6.2.3 Adiposity

Facial adiposity, defined as the perception of weight in the face, has profound effects on perceived attractiveness and perceived health (Coetzee, Perrett, & Stephen, 2009). Facial adiposity is an accurate indicator of actual body mass index (BMI; Coetzee et al., 2009) and other measures of adiposity such as width-to-height ratio (Coetzee, Chen, Perrett, & Stephen, 2010). Based on the well-established link between BMI to either facial adiposity as well as reduced immune function (Samartin & Chandra, 2001; Balkau et al., 2007), facial adiposity is suggested to serve as a valid cue of immunocompetence. Indeed, perceptions of facial adiposity were associated with self-reported frequency of respiratory infections, antibiotic use, and measures of cardiovascular diseases (Coetzee et al., 2009). Adiposity assessed from face photographs in adolescence predicted the weight and health problems, as well as premature death from non-accidental causes and heart disease mortality, in adulthood (Reither, Hauser, & Swallen, 2009). Furthermore, facial adiposity was negatively associated with immunocompetence and mediated the link between attractiveness and immunocompetence (Rantala et al., 2013).

These results demonstrate that facial adiposity conveys information about immune function and health, which is consistent with research demonstrating adiposity to be an important predictor of long-term health consequences.

6.2.4 Skin Color

As the skin covers the surface of the face, it seems very unlikely to make attractiveness judgments while disregarding the skin. In fact, skin color affects naive raters' perceptions of both attractiveness

and health (de Lurdes Carrito et al., 2016; Whitehead, Re, Xiao, Ozakinci, & Perrett, 2012; Stephen et al., 2012). The three main color components of facial attractiveness are: redness, yellowness, and lightness. These components are also strongly linked to face-based perceptions of health. In an experiment, participants increased all three skin color components to enhance healthy appearance in male face photographs (Stephen, Smith, Stirrat, & Perrett, 2009).

Skin redness has profound effects on the perceptions of attractiveness and health (Re, Whitehead, Xiao, & Perrett, 2011; Thorstenson, Pazda, Elliot, & Perrett, 2017). The enhanced attractive and healthy appearance caused by skin redness has been attributed to increased blood perfusion of the skin and oxygenation, which are closely linked to current cardiovascular fitness (Ainslie et al., 2008).

Facial yellowness positively predicts perceived attractiveness (Scott et al., 2010) and perceived health (Stephen, Coetzee, & Perrett, 2011). The more positive evaluation of the facial appearance associated with increased skin yellowness is due to increased levels of carotenoids (Alaluf, Heinrich, Stahl, Tronnier, & Wisemann, 2002). Carotenoids are contained in fruits and vegetables, and are associated with increased resistance to reactive oxygen species (Dowling & Simmons, 2009). As carotenoid levels are depleted in fighting and averting illness; skin yellowness is an indicator of current immunological capacity. An increase in carotenoids equal to 3.3 portions of fruits and vegetables a day enhanced the perceptions of both attractiveness and health (Whitehead et al., 2012).

Facial lightness is primarily affected by melanin, with higher melanin pigmentation darkening the skin. Melanin protects from ultraviolet (UV) radiation by filtering UV rays and reduces the risk of developing skin cancer and sunburn (Robins, 2009). However, high melanin levels entail a health cost, as melanin's UV-filtering properties inhibit vitamin D_3 synthesis, which could lead to vitamin D_3 deficiency (Jablonski & Chaplin, 2000). High levels of vitamin D_3 are essential for calcium absorption which affects bone mineral density (Jablonski & Chaplin, 2000). Facial lightness positively predicted attractiveness in British Caucasian men and had a curvilinear relationship with attractiveness in African men (Stephen et al., 2012).

Taken together, skin color can have a great impact on facial attractiveness and raters' perceptions of health. It is also indicative of the current state of physical health due to its link to cardiovascular fitness and carotenoid level.

6.2.5 Integration of Findings

Although masculinity, averageness, symmetry, adiposity, and skin color have all been associated with attractiveness, they were generally studied individually. Only a few studies simultaneously examined the relationship between several components of attractiveness and health.

Peters, Rhodes, and Simmons (2008) investigated whether facial attractiveness or its components are predictive of semen quality. Despite the link between facial attractiveness and semen quality found in a prior study (Soler et al., 2003), they did not find any relationship between semen quality and neither facial attractiveness nor its components, thus suggesting that facial attractiveness

per se is not a cue for reproductive success. Furthermore, Gangestad and colleagues (2010) examined whether masculinity and fluctuating asymmetry are associated with oxidative stress, derived from measures of oxidative damage to the DNA and lipids. Both masculinity and fluctuating asymmetry negatively predicted oxidative stress, thus suggesting that masculinity and symmetry are cues for health and fitness.

Foo, Simmons, and Rhodes (2017) were the first to comprehensively examine the link of all components of facial attractiveness to various measures of health, including immune function, oxidative stress, and semen quality. Male attractiveness was positively predicted by masculinity, symmetry, and averageness, and negatively by adiposity. Skin color did not predict facial attractiveness. In terms of physical health, masculinity was a predictor of semen quality, suggesting that masculinity may be a signal of male fertility. Consistent with previous studies, their findings demonstrate the importance of sexual dimorphism, symmetry, averageness, and adiposity in determining attractiveness. Besides predicting attractiveness, masculinity also positively predicted semen quality, which supports the phenotype-linked fertility hypothesis (Sheldon, 1994). In contrast to Gangestad and colleagues' finding, facial attractiveness was not related to men's oxidative stress or immune function.

6.2.6 Summary

Masculinity, symmetry, averageness, adiposity, and skin color play important roles in the perceptions of both attractiveness and health. However, instead of fully supporting the "beautiful is good" stereotype, there is inconclusive evidence of a link between facial attractiveness and actual health.

6.3 Perceived Facial Aging and Health

This chapter focuses on perceived facial aging and its potential as being a biomarker for healthy aging. Individuals are capable of accurately estimating the age based on facial appearance due to the evolutionary significance it holds for inferring the competence of others and their ability to cause harm (Fiske et al., 2007). The capability of estimating the age has been used by physicians to judge the health of patients and has been emphasized more recently by gerontology research to determine the perceived age of an individual (how old the person looks to others) as biomarker for healthy aging (Christensen et al., 2009; Gunn et al., 2008).

6.3.1 Definition and Measurement of Perceived Facial Aging

Aging is an inevitable process and has a number of profound effects on facial appearance (Enlow & Moyers, 1982; Berry & McArthur, 1986; Krejci-Papa & Langdon, 2006). Facial aging is one of the most prominent and immediately apparent phenotypes of aging (Chen et al., 2015). It is a multifactorial, three-dimensional process involving volume loss, volume descent, and skin alterations with anatomic, biochemical, and genetic correlates (Wulc, Sharma, & Czyz, 2012). In particular, skin and soft tissues play an important role in showing signs of facial aging (Coleman & Grover, 2006;

Zimbler, Kokoska, & Thomas, 2001; Asakura et al., 2009). It is equally evident that loss of facial bone volume greatly contributes to age-related facial alterations. Larger eye sockets, reduced angle of brow, and an increase in mandibular angle resulting in blunting or loss of definition of the lower jaw represent all consequences of aging (Shaw et al., 2011). As facial aging is a complex process involving changes of soft tissues and skeleton structures, it is, to a degree, reflective of biological aging and is influenced by intrinsic and extrinsic aging factors (Gunn, 2015). Synergistic effects of intrinsic and extrinsic aging factors throughout the life span are responsible for facial aging (Friedman, 2005).

Intrinsic aging is solely caused by internal factors. Intrinsic structural changes are genetically determined and represent a natural consequence of aging. Intrinsic facial aging is fairly uncontrollable and largely based on hereditary factors (Sveikata, Balciuniene, & Tutkuviene, 2011). Intrinsic aging of the skin occurs inevitably as a natural consequence of age-related physiological changes at genetically determined rates (Bergfeld, 1997). Intrinsic aging represents chronological aging and is an inherent degenerative process on the basis of reduced physiological functions and capacities. It is characterized primarily by functional changes rather than by gross morphologic alterations in the skin (Yaar, Eller, & Gilchrest, 2002). Despite only minor changes in gross and histologic cutaneous appearance, maximal function and reserve capacity deteriorate with aging. Histologically, the flattening of the dermal epidermal junction represents the most consistent change of intrinsic cutaneous aging (Yaar & Gilchrest, 2001). The intrinsic rate of skin aging can be dramatically influenced by external environmental factors.

Extrinsic aging represents a distinct process caused by external factors. Extrinsic skin aging factors are to different degrees controllable, and include exposure to sunlight, air pollution, smoking, repetitive muscle movements like frowning, and lifestyle factors such as diet, sleeping position, or overall health (Bergfeld, 1997). Two major exogenous factors, both of which exert a heavy toll on the facial skin, are smoking (Kennedy et al., 2003; Okada, Alleyne, Varghai, Kinder, & Guyuron, 2013) and exposure to UV light (Friedman, Lim, & Wang, 2016; Yaar & Gilchrest, 1998). Epidemiologic studies showed that smoking has deleterious effects on the skin (Morita, Torii, Maeda, & Yamaguchi, 2009; Yin, Morita, & Tsuji, 2003). The other main cause for premature skin aging - besides smoking - is sun exposure, with a multiplicative effect found when sun exposure coexisted in a long history of smoking (Kadunce et al., 1991). UV light and smoking independently cause skin wrinkling and their combination seems to amplify the effect (Yin, Morita, & Tsuji, 2001).

Given the myriad of changes that age brings to the face, age estimation may represent a valid approach to capture the key facial cues indicative of age. The most applied method of studying facial aging is likely also the most intuitive: participants are presented with a face photograph and are instructed to estimate the age of the target, mostly by rounding to the next year or including years and months in the estimate (Rhodes, 2009). This estimation of age based on facial appearance is termed "perceived age". Other methodologies that measure perceived facial aging have been less frequently employed. For instance, participants categorize presented face photographs as those of a younger or older person (Bruyer, Mejias, & Doublet, 2007) or to group faces into categories, such as young,

middle-aged, or older adults (Anastasi & Rhodes, 2005, 2006). Age estimates can be fairly accurate when estimating the age of individuals. Burt and Perrett (1995) had younger and older adults estimate the age of individuals aged 30 to 54 on face photographs. Perceived age deviated only slightly (2.39 years) from the chronological ages of the individuals pictured. George and Hole (2000) reported similar levels of accuracy, with deviations of approximately three years from chronological age. Sörqvist and Eriksson (2007) reported that the accuracy of estimation depends on the chronological age of the individuals pictured in the face photographs. The difference between chronological and perceived age varied between two and six years, depending on the chronological age and the age of the raters. Christensen and colleagues (2009) compared three groups of raters with different professional background (geriatric nurses, young male student teachers, and older women) in terms of reliability and accuracy. Perceived age showed high reliability (α = 0.82 - 0.94) in all three rating groups. The mean of perceived age was close to the mean of chronological age; within one year in all rater groups, except the older raters who overestimated the ages by an average of 1.7 years. Overall, perceived age was underestimated for the oldest and overestimated for the youngest individuals. Moyse and Brédart (2012) observed an own-age bias on age estimation; adults were more accurate when estimating the age of their in-group faces. Taken together, the studies mentioned above indicate that individuals seem to be remarkably accurate in estimating the age of unfamiliar faces.

6.3.2 Perceived Age as a Biomarker for Healthy Aging

When assessing health, physicians habitually compare perceived and chronological age. This practice, which has existed for centuries, suggests an implicit assumption that patients who appear older than their chronological age are more likely to be in poor health. Therefore, perceived age seems to be a valuable cue in the healthcare system, where it is used as an indicator of physical health. Although clinicians use perceived age as part of their assessment of patients, research on the validity of the approach was a long time sparse.

Borkan and Norris (1980) were the first to examine the link between perceived age and health. In the Baltimore Longitudinal Study of Aging, men aged between 17 and 102 had their perceived age rated by a physician. These ratings were significantly associated with men's scores on 7 of 24 biomarkers of aging: maximum breathing capacity, serum globulin, plasma glucose, creatinine clearance, two measures of tapping time, and foot reaction time. A subsequent study on the same sample showed that perceived age was also associated with mortality. Perceived age, controlled for chronological age, was on average one year lower for the survivors than for the deceased (Borkan, Bachman, & Norris, 1982). Two decades later, Bulpitt, Markowe, and Shipley (2001) used age estimations during a face-to-face contact from nurses and physicians. They assessed the difference between perceived and chronological age according to 20 objective measures of health. In men, looking older than their chronological age was positively related to total serum cholesterol and blood hemoglobin.

These initial studies indicate the validity of perceived age to signal health. However, the ratings of perceived age were performed by physicians and nurses prior to a medical examination.

This brief face-to-face contact reveals a number of other cues that may affect estimates of age (i.e. walking speed, voice), suggesting that non-facial characteristics of an individual affected the age estimates. Recent research examined perceived age obtained solely from face photographs. All of the studies investigating the link between perceived facial age and health are reviewed below and summarized in Table 1.

Christensen and colleagues (2004) were the first to examine perceived age rated solely on face photographs. In the Longitudinal Study of Aging Danish Twins, they used nurses to assess perceived age and carried out a two-year follow-up of mortality. Their results showed that perceived age predicted short-term mortality and that genetic factors can explain approximately 60% of the variation in perceived age. Subsequently, Christensen and colleagues (2009) investigated whether perceived age is a robust biomarker for healthy aging as indicated by its widespread use in clinical practice. They used different groups of raters (geriatric nurses, young males, older women) to assess perceived age of twins from a face photograph. They also assessed different biomarkers of aging (grip strength, cognitive and physical functioning, leukocyte telomere length) and implied a seven-year follow-up of mortality. Their results showed that perceived age was associated with all biomarkers of aging and mortality across all groups of raters, even after adjustment for chronological age, sex, and other biomarkers of aging. The association between perceived age and mortality did not decrease during the follow-up period; thus, indicating that perceived age is not only predictive of short-term mortality. For the dizygotic twin pairs the likelihood that the older looking twin died first increased significantly with a higher difference in perceived age within the pair. However, there was no such association for monozygotic twins. Overall, Christensen and colleagues (2009) showed that perceived age obtained from static face photographs is a robust biomarker for healthy aging independent of the sex, age, and professional background of the raters. Analyzing the same sample, Gunn, Larsen, Lall, Rexbye, and Christensen (2016) created two new images per twin pair by swapping them. Changing the face or its surrounding resulted in only a marginal difference between their effect sizes. Perceived age, adjusted for chronological age and sex, remained a significant predictor of mortality up to seven and twelve years. The surrounding of the image (such as hair or clothing cues) had no effect on mortality. These findings indicate that facial appearance, but not hair or clothing cues, is responsible for the link between perceived age and survival.

Dykiert and colleagues (2012) aimed to replicate and extend the findings of Christensen and colleagues (2004, 2009). They used face photographs of individuals with a small age-range (82-84.6 years) to be rated in terms of perceived age by young adults and analyzed associations between perceived age and mortality during a seven-year follow-up. Despite the marginal variance in chronological age, the range of perceived age was 20 years (63.5-85.3 years). Perceived age was negatively associated with perceived health, satisfaction with life, and cognitive function. Perceived age, adjusted for sex and chronological age, predicted mortality and remained a significant predictor even after controlling for satisfaction with life and cognitive function. Their results suggest perceived age to be a significant predictor of mortality among older people, with predictive value above and beyond that of objective or subjective health status and cognitive function.

In their longitudinal study, Agrigoroaei and colleagues (2016) found a significant negative association between perceived age and functional health. Controlling for the difference between perceived and chronological age at Time 1, those with worse functional health were perceived older than their chronological age at Time 2 compared to those with better functional health. In contrast, self-rated physical health and chronic health conditions were not associated with perceived age. Consequently, the authors suggested that functional health is a visible cue to others, whereas chronic health conditions are not always manifested in the facial appearance.

Further studies investigated the link between perceived age and both glucose and cortisol levels. Noordam and colleagues (2012) aimed at investigating whether cortisol levels are associated with perceived age. They reported a positive association between serum morning cortisol levels and perceived age; thus, suggesting that perceived age may be associated with depression due to the positive link between depression and cortisol levels (Brown, Varghese, & McEwen, 2004). Van Drielen and colleagues (2015) replicated the positive association between perceived age and cortisol. They further showed that glucose levels were positively linked to perceived age (Noordam et al., 2013; van Drielen et al., 2015).

Table 1. Overview of the literature on perceived age as a biomarker for healthy aging

Study and Authors	Sample Size Men	Women	M_{age}	Measures	Findings
Midlife in the United States Longitudinal Study Agrigoroaei, Lee-Attardo, & Lachman (2016)	Total: 221		50	Perceived age rated by 10 females and 9 males aged 19 to 79 years Health measures (self-reports of physical health, functional health, and chronic health problems) Ten-year follow-up	Significant longitudinal associations between perceived age and functional health (b = –.20).
Longitudinal Study of Aging Danish Twins Christensen, Iachina, Rexbye, Tomassini, Frederiksen, McGue, & Vaupel (2004)	82 MZ 94 DZ	93 MZ 118 DZ	76	Perceived age rated by 20 female nurses aged 25 to 46 years Intra-pair correlation for perceived age Mortality: Two-year follow-up	Intra-pair correlation for perceived age within MZ twins (r = .59) and DZ twins (r = .29). Heritability of perceived age is approximately 60%. Among 49 pairs where at least one pictured twin died, the longer-surviving twin had been rated as looking younger than his co-twin (mean difference = 1.15 years).
Longitudinal Study of Aging Danish Twins Christensen, Thinggard, McGue, Rexbye, Hjelmborg, Aviv, Gunn, van der Oderaa, & Vaupel (2009)	352	422	76	Perceived age rated by 20 female nurses aged 25 to 46 years, 10 men aged 22 to 37 years, 11 women aged 70 to 87 years Biomarkers of aging (grip strength, physical and cognitive functioning, leukocyte telomere length) Mortality: Seven-year follow-up	Perceived age was associated with all biomarkers of aging (r = –.11, –.25), controlled for chronological age and sex. Perceived age predicted survival after adjustment for other biomarkers of aging and chronological age (hazard ratio = 1.08). A one year increase in perceived age led to a 3% increase in the mortality risk.
Baltimore Longitudinal Study of Aging Dykiert, Bates, Gow, Penke, Starr, & Deary (2012)	133	159	83	Perceived age rated by 6 female and 6 male students Health measures (perceived health, grip strength, blood pressure, cognitive function, satisfaction with life) Mortality: Seven-year follow-up	Perceived age was negatively associated with perceived health (r = –.55), cognitive functioning (r = –.14) and satisfaction with life (r = –.19). Perceived age predicted mortality (hazard ratio = 1.36), controlled for sex and

					chronological age.
Longitudinal Study of Aging Danish Twins Gunn, Larsen, Singh Lall, Rexbye, & Christensen (2016)	142	232	76	Perceived age rated by 10 assessors Mortality: Seven-year and twelve-year follow-up	Perceived age predicted seven- and twelve-year survival after adjustment for chronological age and sex (hazard ratio = 1.17 and 1.06, respectively). A 1.4-year difference in perceived age within a twin pair resulted in a higher mortality risk for the older looking twin.
Leiden Longevity Study Noordam, Gunn, Tomlin, Rozing, Maier, Slagboom, Westendorp, van Heemst, & de Craen (2012)	139	137	63	Perceived age rated by 60 assessors Cortisol in serum	Levels of morning cortisol levels were positively associated with perceived age. A 0.1 mmol/l increase in serum morning cortisol level was associated with a 0.51-year increase in perceived age.
Leiden Longevity Study Noordam, Gunn, Tomlin, Maier, Mooijaart, Slagboom, Westendorp, de Craen, van Heemst (2013)	Total: 602		64	Perceived age rated by 60 assessors Glucose levels in serum	Glucose levels were positively associated with perceived age. A 1 mmol/l increase of glucose was associated with a 0.4-year increase in perceived age.
Leiden Longevity Study van Drielen, Gunn, Noordam, Griffiths, Westendorp, de Craen, & van Heemst (2015)	Total: 798		63	Perceived age (rated by 60 assessors) Glucose levels in serum (non-fasted and fasted) Cortisol levels in serum	Non-fasted glucose levels and cortisol levels were positively associated with perceived age (b = .63 and b = .52, respectively).

Note. MZ: monozygotic; DZ: dizygotic

6.3.3 Factors influencing the Perceived Facial Aging

Previous studies provided empirical evidence for perceived age to be a biomarker for healthy aging. However, there is more limited work with respect to the predictors of perceived age. According to Christensen and colleagues (2004), approximately 40% of the variation in perceived age is due to non-genetic factors. Therefore, extrinsic factors may have long-term effects on perceived age (Gunn et al., 2015). Empirical evidence primarily highlights the role of health-damaging behaviors, such as sun exposure and smoking, that can lead to an older facial appearance (Friedman et al., 2016; Okada et al., 2013). Other studies point to a negative association between BMI and wrinkles (Guinot et al.,

2002; Purba et al., 2001). However, there is a lack of studies examining the influence of psychosocial factors on perceived facial aging.

Rexbye and colleagues (2006) were the first to examine the relationship between psychosocial factors and perceived age. In the Longitudinal Study of Aging Danish Twins, sun exposure and smoking were associated with an older appearance, whereas a high BMI, high social status, a low depression symptomatology score, and having one to three children were related to a younger appearance. Both smoking 20 cigarettes per day for 20 years and a decrease of two BMI units affected perceived age in the same way by aging one year. Shifting social status from highest to lowest corresponded to a 3.5-4 years' difference in perceived age. A change of the depression symptomatology score from 17 to 49 was equivalent to aging 2.4 years. Marital status did not have a significant effect on perceived age. For men, the effect of being married compared with never married corresponded to a one-year decrease in perceived age. Furthermore, having one to three children compared to having none or more than four children had a tendency to decrease perceived age.

In their study on perceived age and mortality, Dykiert and colleagues (2012) reported that satisfaction with life, assessed with the statement "In many ways, my life is close to my ideal", is associated with a younger facial appearance. The authors suggested a common factor in that younger-looking individuals have a better subjective well-being and are healthier.

A recent study focused on financial stress as a potential predictor of perceived age (Agrigoroaei et al., 2016). The researchers expected those with higher levels of financial stress to be perceived as being older than their chronological age. Ratings of perceived age based on face photographs were taken at two points in time, an average of ten years apart, allowing the examination of predictors of change in perceived age. As predicted, financial stress played a specific role for perceived age. Those with higher levels of financial stress were perceived as being older than their chronological age to a greater extent than those with less financial stress, while adjusting for income. The same pattern of results was obtained longitudinally, when changes in perceived age were examined over time. Controlling for the difference between perceived and chronological age at Time 1, those with more financial stress were perceived older than their chronological age at Time 2, compared to those with less stress over finances. This study contributes to the existing literature by highlighting the role of stress in understanding individual differences in age-related facial appearance.

6.4 Summary

Previous research highlights the relevance of perceived age in indicating mortality risk and objective health states. Furthermore, perceived age seems to be a biomarker for healthy aging by providing more information about an individual's health above and beyond chronological age. It is a quantifiable parameter which reflects biological aging, thus identifying those at risk of aging-related conditions, diseases, and mortality. Despite the strong evidence for perceived age as a biomarker for healthy aging, only a few studies examined potential influencing factors on perceived age. While smoking and photo aging are well-established external factors of skin-aging, only three studies hitherto examined

the role of psychosocial factors in perceived age (Rexbye et al., 2006: social status, depression symptomatology; Dykiert et al., 2012: satisfaction with life; Agrigoroaei et al., 2016: financial stress).

7. Conclusions, Aims, and Research Questions

Previous research indicates that facial appearance provides some valid information about its wearer. While a broad range of personality traits and health outcomes has been found to be associated with facial appearance, the research literature is still far from conclusive. Therefore, the primary aim of the present thesis is to gain novel insights into facial appearance and its association with both personality and health. The research literature had been systematically reviewed and - based on the theoretical background - two empirical studies were conducted. The purpose of the two studies is to empirically evaluate specific facial features that can act as determinants of observer perceptions of target persons. In particular, perceived age and facial width-to-height ratio were assessed in terms of their association with health and personality, respectively.

The theoretical background first focused on inferences of personality traits from facial appearance. Modern research indicates face shape, in particular the fWHR, to be a valid biomarker for dominance. To date, however, only a few studies investigated the mechanisms by which fWHR associates with dominance, and many of them failed to consider important confounding or moderating factors. In particular, the moderating role of social, psychological, and biological factors, which might determine whether face shape is associated with dominance-related behavioral traits, needs to be further established. Therefore, future research should incorporate potential influencing factors when investigating the link between fWHR and dominance. Social status has been shown to be an important influencing factor on the link between fWHR and actual aggressive behavior. However, it is not yet clear whether social status influences the link between fWHR and other personality traits but also self-reports of aggression. Besides social status, testosterone seems to play an important role in the relation between fWHR and personality. As testosterone is responsible for the development and expression of both face shape and dominance-related behavioral traits, it is assumed to be the underlying mechanism linking both. However, while some research showed a positive association between baseline testosterone and fWHR, the link could not be replicated in other studies. Consequently, the effects of adult testosterone on the link between fWHR and behavioral personality traits remain unclear. The first empirical study outlined in this thesis aims at investigating the influence of both social status and testosterone on the link between fWHR and dominance-related behavioral traits. In particular, the association between fWHR and self-reports of aggression and the Dark Triad are explored. The study is based on a sample of $N = 109$ apparently healthy men aged 40 to 75 years reporting subclinical signs of vital exhaustion. In line with previous research, we hypothesized that social status moderates the link between fWHR and dominance-related traits, so as fWHR is associated with self-reports of aggression and the Dark Triad only in men reporting a low income. Furthermore, we explored the link between fWHR and testosterone and thus investigated the influence of testosterone on the association between fWHR and dominance. We expected testosterone to be positively associated with fWHR and to influence the relationship between fWHR and dominance-related personality traits.

Next, the theoretical background concentrated on facial attractiveness and perceived age as proposed potential cues of health. A review of the previous literature showed, while facial attractiveness is associated with subjective perceptions, attitudes, and discriminatory behaviors, that it is not a valid predictor of one's actual health. By contrast, perceived age has been shown to be a valid biomarker for healthy aging by being associated with other phenotypes of aging and by predicting mortality above and beyond chronological age. Although a recent study showed that 40% in perceived age are due to non-genetic factors and despite the strong link between perceived age and health outcomes, the literature on factors influencing perceived age is scarce. Only three studies hitherto investigated the association of psychosocial factors with perceived age. In particular, whereas a high social status, being married, and satisfaction with life have been linked to a younger facial appearance, depression symptomatology and financial stress have been associated with an older facial appearance. Due to the limited work on influencing factors, future research is highly encouraged to examine the influence of other psychosocial factors on perceived age. Therefore, the second empirical study of this thesis investigates the association of perceived age with psychosocial resources. In particular, optimism, self-esteem, and relationship satisfaction have been shown to be key psychosocial resources for mental health. In a sample of $N = 223$ self-reporting healthy men aged 40 to 75 years, the role of these psychosocial resource factors in perceived age is analyzed. We hypothesized that these psychosocial resources might have beneficial effects through mental health on perceived facial aging.

To conclude, the overall aim of this thesis is to gain knowledge about bio-psychosocial factors of facial appearance, which might contribute to the understanding of the mechanisms linking facial appearance to both personality and health. As facial appearance plays a significant role in social interactions and daily life outcomes, it is of great interest to detect bio-psychosocial factors involved in face evaluation.

PART II: EMPIRICAL STUDIES

8. Facial Width-to-Height Ratio as Biomarker for Dominance depends on Social Status and Testosterone

8.1 Introduction

A rapidly growing amount of research has established associations between men's facial width-to-height ratio (fWHR; Weston, Friday, & Liò, 2007) and a broad range of personality traits and behaviors. In particular, studies indicated that greater fWHRs are associated with socially undesirable personality characteristics and dominance-related behaviors, including being less trustworthy (Stirrat & Perrett, 2010), more self-centered and deceptive (Geniole, Keyes, Carré, & McCormick, 2014; Haselhuhn & Wong, 2011), more psychopathic (Anderl et al., 2016), and more aggressive (Carré, McCormick, & Mondloch, 2009). However, research has also identified positive correlates of fWHR, as men with greater fWHRs have been found to be more cooperative in the context of inter-group competition (Stirrat & Perrett, 2012). Moreover, professional combatants with greater fWHRs showed better physical formidability and fighting ability (Třebický et al., 2015; Zilioli et al., 2015), and chief executive officers with greater fWHRs achieved superior financial performance (Wong, Ormiston, & Haselhuhn, 2011). In sum, a great fWHR is assumed to be a reliable biomarker for social dominance and motivation to achieve power.

Besides social dominance and power motivation, fWHR is related to human aggression. Carré and McCormick (2008) demonstrated a positive association between fWHR and aggressive behavior in professional hockey players. The authors suggested that fWHR may be an honest signal of propensity for aggression, which has been supported by recent research: fWHR was related to self-reported aggression as measured by the Aggression Scale (Buss & Perry, 1992; Lefevre, Etchells, Howell, Clark, & Penton-Voak, 2014) and correlated strongly with judgments of aggression made by observers (Geniole, Molnar, Carré, McGornick et al., 2014). However, some studies failed to replicate the link between fWHR and aggression. For instance, Deaner, Goetz, Shattuck, and Schnotala (2012) demonstrated that body weight but not fWHR predicts aggressive behavior in professional hockey players. Furthermore, Oezener (2012) found no association between fWHR and self-reported aggression as measured by the Aggression Scale. The reasons for these inconsistencies are still unclear. However, most of the studies did not control for important influencing factors. For instance, Muñoz-Reyes, Gil-Burmann, and Turiegano (2014) stated that fWHR should only be used after controlling for body mass index (BMI). Moreover, although social status is considered as an important factor influencing the relationship between fWHR and aggression (Goetz et al., 2013), none of the aforementioned studies considered social status in their analyses of the relationship between fWHR and aggression.

Besides aggression, antisocial personality traits such as psychopathy, Machiavellianism, and narcissism, also known as the Dark Triad, may be related to fWHR. These three disagreeable and aversive constellations of personality traits share a common core of significant harm or exploitation of

others (Book, Visser, & Volk, 2015; Furnham, Richards, & Paulhus, 2013). Even at subclinical levels, psychopathy (callous, impulsive, and predatory behaviors), narcissism (excessive ego and selfish behavior), and Machiavellianism (calculated social manipulation) are linked to significant social, emotional, and legal harm (Furnham, et al., 2013). Besides the harm they cause to others, these personality traits may yield significant immediate and evolutionary benefits (Book et al., 2015). Each of the three Dark Triad personality traits is characterized by ruthless self-advancement (Zuroff, Fournier, Patall, & Leybman, 2010), which may exploit the evolved cooperative behaviors of most people while eliminating the evolved need to reciprocate (Cosmides & Tobby, 1992).

So far, the relationship between fWHR and the Dark Triad has not been examined. However, Anderl et al. (2016) detected a positive correlation between fWHR and psychopathy, measured with the Psychopathic Inventory-Revised (Lilienfeld & Widows, 2005). As fWHR has been shown to be associated with other socially undesirable personality traits such as being untrustworthy or deceptive (Geniole et al., 2014; Haselhuhn & Wong, 2011; Stirrat & Perrett, 2010), we assume a positive association between fWHR and the Dark Triad. Previous research has indicated that both fWHR (Geniole, Denson, Dixson, Carré, & McCormick, 2015) and the Dark Triad (Jonason, Webster, Schmitt, Li, & Crysel, 2012) are part of an evolved system of social dominance and power. With regard to the Dark Triad, the evolved system serves as a short-term and exploitative social strategy that emphasizes personal gains at the expense of cooperation (Jonason, et al., 2012). Similar to aggression, the Dark Triad personality traits can therefore be seen as risk-taking strategies to fulfill the needs of men with great fWHRs for power and social dominance.

Social status is considered as one important factor influencing the relationship between fWHR and dominance-related traits (Goetz et al., 2013). A high social status is defined in this regard as having greater personal resources, such as higher income (Kraus, Piff, Mendoza-Denton, Rheinschmidt, & Keltner, 2012). Although income and education are both facets of social status, they reflect distinct bases of hierarchical differentiation (Magee & Galinsky, 2008). Income, but not educational level, was found to predict unethical behavior (Dubois, Rucker, & Galinsky, 2015). Moreover, income is related to control over valued resources and is therefore more likely to be intrinsically linked to dominance and power. Vohs, Mead, and Goode (2006) found that exposure to money can lead to similar consequences to power, such as an increase in self-focus. In addition, a lack of power increases people's need for money (Dubois, Rucker, & Galinsky, 2010).

Based on the hypothesis that fWHR is part of an evolved cueing system of social dominance and power (Geniole et al., 2015), men with great fWHRs should display a greater need for power and be more willing to take risks to achieve resources such as money. A high income might increase feelings of powerfulness and dominance and may therefore act as a source of power for men with great fWHRs. By contrast, men with great fWHRs but low income might be faced with a discrepancy in the needs and resources for power and social dominance. Due to their elevated need for social dominance and power, men with great fWHRs should be more likely to engage in dominance-related behaviors in situations of high need such as low income. Indeed, there is initial evidence for the influence of income in the relationship between fWHR and dominance. Goetz et al. (2013) showed

that income moderated the relationship between fWHR and aggressive behavior, and confirmed that fWHR is a robust predictor of aggression, but only in the context of low income. The role of social status as a moderator of the relationship between fWHR and social dominance has also been documented in non-human primates (Lefevre et al., 2014). Carré (2014) showed that fWHR was only related to dominance-related behaviors among low-status monkeys. Likewise, a recent human study demonstrated moderating effects of social status on the relationship between fWHR and risk-taking in men (Welker, Goetz, & Carré, 2015). Overall, these findings highlight the importance of taking social status into account when examining the link between fWHR and dominance-related traits and behaviors.

Finally, as one of the most prominent male hormonal parameters, testosterone has been proposed as a common underlying factor linking fWHR to dominance-related traits and behaviors (Lefevre, Lewis, Perret, & Penke, 2013). Testosterone affects both the craniofacial growth and the expression of behavioral traits as part of sexual differentiation in adolescence, and might therefore be responsible for the link between fWHR and dominance-related traits (Carré & McCormick, 2008). Indeed, baseline and reactive testosterone levels in men were positively linked to fWHR (Lefevre et al., 2013) and baseline testosterone was positively related to self-reported dominance (Carré, Putnam, & McGormick; 2009). However, a recent analysis demonstrated no significant positive relationship between fWHR and baseline testosterone (Bird et al., 2016). These inconsistent findings might be attributable to the failure to include relevant co-variables such as BMI.

Taken together, a great fWHR seems to be a relevant biomarker for dominance-related outcomes. However, previous findings indicated that fWHR is positively associated with objective aggression at a low income only. It has not yet been examined whether income influences the relationship between fWHR and self-reports of dominance-related traits. In particular, it is not known whether the link between fWHR and self-reported aggression is dependent on income. Moreover, the relationship between fWHR and the Dark Triad is still unexplored. Finally, the role of testosterone in the link between fWHR and dominance-related traits remains unclear.

The primary aim of the present study was to explore the relationship between fWHR and self-reported dominance-related traits: a broad range of aggression (physical, verbal, anger, hostility) and the Dark Triad. This is the first study to investigate whether the association between fWHR and these dominance-related traits depends on social status defined by income. We assumed a positive relationship between fWHR and the dominance-related traits only at a low income. Furthermore, the study is the first to examine the potential role of testosterone as an underlying biological mechanism in the relationship between fWHR and these dominance-related traits. We expected testosterone to be correlated with fWHR and to be an important influencing factor in the relationship between fWHR and the dominance-related traits.

8.2 Methods

The data for the present study were collected as part of a larger cross-sectional project entitled Men Stress 40+. In the following, only procedures and measures used for the present study are described. For more detailed information about the project, see Noser, Fischer, Ruppen, & Ehlert (submitted).

8.2.1 Participants and Procedure

A total of 123 men provided psychometric and biological data. Participants were recruited through local online platforms, newspaper announcements, and flyers. In addition to male gender and age between 40 and 75 years, inclusion criteria for study participation were no self-reported mental disorder or physical disease, no consumption of psychotropic substances during the past two months, no psychotherapeutic intervention in the past six months, and no more than two standard units of alcoholic beverages per day. In order to only include participants with a current working income, retired men were excluded from data analyses (n = 13). Additionally, one subject did not provide consent for the facial image and was therefore excluded. The final sample consisted of N = 109 men currently residing in Switzerland or Germany. Participants had an average age of 50.92 years (SD = 6.71). Forty-four percent (n = 48) of the sample had attained tertiary education. The annual gross income ranged from 18'000 to 700'000 Swiss francs, with a mean of 137'972.94 (SD = 88'717.26). The participants had an average body mass index of 25.77 (SD = 3.83). With respect to medication intake, 80% (n = 87) of the sample did not take any medication; the most frequently taken medications in the remaining participants were antihypertensive drugs (n = 15) and medications to treat high cholesterol (n = 6). All participants provided written informed consent. The Ethics Committee of the Canton of Zurich approved the study protocol before data collection.

The participants independently completed the questionnaires assessing sociodemographic and psychometric data online. Subsequently, they were invited to a single laboratory session at the Department of Psychology of the University of Zurich to provide the biological data. Standardized saliva sampling started at 8:00am to control for diurnal variation of hormone secretion, and subjects' awakening time was recorded. Prior to the salivary assessment, participants were instructed not to consume beverages containing caffeine or alcohol for 48 hours and not to engage in heavy exercise for 24 hours prior to the laboratory session. Three hours before the saliva sampling, they should refrain from smoking, brushing their teeth, chewing gum, and eating. Following the saliva sampling, body measures such as height and weight were recorded. At the end of the examination, participants were photographed using a digital camera on a tripod while standing upright in front of a white background under standardized lighting. To achieve comparable face photographs, participants were instructed not to smile and to maintain a neutral facial expression while being photographed at a standardized camera distance and angle. The picture with the most frontal and neutral recording of each participant's face was used for the measurement of the fWHR.

8.2.2 Measures

Facial width-to-height ratio. Prior to measurement, all pictures were horizontally aligned using Fotor, a software program for editing images (http://www.fotor.com). fWHR was measured by calculating the bizygomatic width (maximum horizontal distance from the left facial boundary to the right facial boundary) to upper-face height (vertical distance from the mid-point of the upper lip to the highest point of the eyelids) ratio from pictures (Lefevre et al., 2013; Stirrat & Perrett, 2010). Two trained raters measured fWHR using the National Institutes of Health open-access ImageJ software (http://rsbweb.nih.gov/ij/). Both raters were blind to the research questions. The measures were highly consistent (α = .99) and were thus averaged into one index of fWHR.

Dark Triad (Dirty Dozen Scale). Participants rated themselves on psychopathy (e.g. I tend to lack remorse; α = .56), Machiavellianism (e.g. I have used deceit or lied to get my way; α = .70), and narcissism (e.g. I tend to want others to admire me; α = .76) using the Dirty Dozen scale (Jonason & Webster, 2010) in its German version (Kuefner, Dufner, & Back, 2014). The Dirty Dozen is composed of 12 items rated on a nine-point Likert scale (1 = totally disagree, 9 = totally agree).

Aggression (Aggression Scale). Participants rated themselves on physical aggression (e.g. I get into fights a little more than the average person; α = .60), verbal aggression (e.g. I often find myself disagreeing with people; α = .62), anger (e.g. I flare up quickly but get over it quickly, α = .81), and hostility (e.g. I wonder why sometimes I feel so bitter about things, α = .71) using a German version of the Aggression Scale (Buss & Perry, 1992) proposed by Amelang and Bartussek (2001). The German version contains the same 29 items and a similar response format to the original version (1 = extremely uncharacteristic of me, 5 = extremely characteristic of me).

Income. The participants were asked to specify their annual gross income in Swiss francs. The annual gross income in the sample ranged from 18'000 to 700'000 Swiss francs, with a mean of 137'972.94 (*SD* = 88'717.26). This lies above the general average income in Switzerland of 86'000 Swiss francs (Federal Statistical Office, 2015).

Testosterone. Saliva samples were obtained at 8:00am using a standardized procedure. Participants were asked to successively fill three salicaps of 2ml capacity (SaliCaps, IBL International GmbH, Hamburg, Germany) with saliva. The saliva samples were stored at –20◦C until required for biochemical analysis. Testosterone was analyzed using Luminescence Immunoassay (IBL International, 2015) in the biochemical laboratory of the Department of Psychology, University of Zurich. Inter- and intra-assay variance of this assay is below 10%.

8.2.3 Analysis

Statistical analyses included several steps and were performed using the IBM Statistical Package for the Social Sciences (SPSS Version 22). Statistical significance was defined as $p < .05$. Potential covariates and confounders estimated from the literature were tested for associations with fWHR by analyzing correlations. As body mass index (BMI) was significantly correlated with fWHR (r = 0.46, p < .00), we entered BMI as control variable in all further analyses. Medication intake as dichotomous

variable was significantly correlated with salivary testosterone (r = 0.20, p < .05) and was therefore entered as additional control variable in the analyses on testosterone. A one-sample Kolmogorov-Smirnov test revealed that testosterone (z = 0.20) did not deviate from a normal distribution. For testosterone, four cases were missing and were removed from the analyses on testosterone.

First, partial correlations between fWHR and the dependent variables were computed. Second, separate moderation analyses using PROCESS (Hayes, 2015) were conducted to examine whether the association between fWHR and the dependent variables was influenced by income. Finally, to test whether testosterone influenced the relationship between fWHR and the dependent variables, further separate moderation analyses were computed. Prior to moderation analyses, all variables were z-standardized and mean-centered. The interaction was probed by testing the conditional effects of fWHR at three levels of the moderator, one standard deviation below the mean, at the mean, and one standard deviation above the mean.

8.3 Results

Descriptive statistics and intercorrelations among fWHR and the dependent variables are shown in Table 2. There was no significant correlation either between fWHR and the Dark Triad or between fWHR and aggression.

Table 2. Descriptive statistics and intercorrelations among the relevant variables

	Mean	*SD*	1	2	3	4	5	6	7	8
(1) fWHR	1.99	0.15	1							
(2) Psychopathy	3.40	1.44	0.10	1						
(3) Machiavellianism	2.85	1.39	0.09	0.48***	1					
(4) Narcissism	4.04	1.71	0.03	0.21*	0.44***	1				
(5) Physical Aggression	14.17	3.79	0.01	0.20*	0.19	0.21*	1			
(6) Verbal Aggression	13.41	3.28	0.01	0.29**	0.23*	0.04	0.24*	1		
(7) Anger	17.22	5.38	0.02	0.28**	0.20*	0.18	0.45***	0.44***	1	
(8) Hostility	18.56	5.24	0.04	0.27**	0.32**	0.29**	0.35***	0.04	0.44***	1

Note. $N = 109$. Control variable: BMI.

Scale range: Psychopathy (1 - 9), Machiavellianism (1 - 9), narcissism (1 - 9), physical aggression (9 - 45), verbal aggression (5 - 25), anger (7 - 35), hostility (8 - 40)

SD, standard deviation. Significance levels (two-tailed): * $p < .05$, ** $p < .01$, *** $p < .001$.

8.3.1 Income as a potential moderator

We were interested in the influence of income on the relationship between fWHR and the dependent variables. Dependent variables were the Dark Triad (psychopathy, Machiavellianism, narcissism) and aggression (physical, verbal, anger, hostility). To test whether fWHR is positively associated with the Dark Triad and aggression only at a low income, separate moderator analyses were conducted.

fWHR was not a significant predictor of psychopathy, $b = 0.07$, $p = .59$, and the moderator income also did not significantly predict psychopathy, $b = 0.05$, $p = .65$. In contrast, the interaction between fWHR and income was a significant predictor of psychopathy, $b = -0.34$, $p < .05$. The interaction significantly increased the explained variance in psychopathy, $F(1, 104) = 4.82$, $p = 0.03$, $\Delta R^2 = .05$. This interaction is illustrated in Figure 3. fWHR was only a significant predictor of psychopathy at a below-average income, $b = 0.41$, $p < .05$.

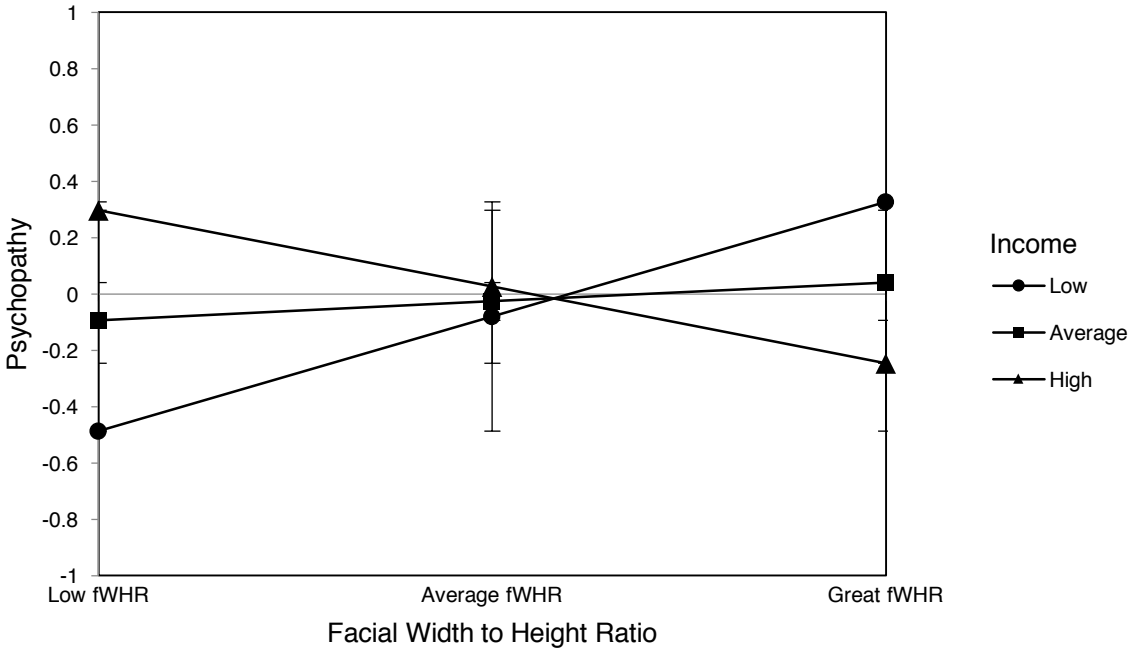

Figure 3. Interaction plot of the relationship between facial width-to-height ratio and psychopathy moderated by income.

fWHR was not a significant predictor of Machiavellianism, $b = 0.05$, $p = .65$. Similarly, the moderator income did not significantly predict Machiavellianism, $b = -0.04$, $p = .74$. In contrast, the interaction between fWHR and income was a significant predictor of Machiavellianism, $b = -0.41$, $p < .01$. The interaction significantly increased the explained variance in Machiavellianism, $F(1, 104) = 7.22$, $p = 0.01$, $\Delta R^2 = .07$. This interaction is illustrated in Figure 4. fWHR was only a significant predictor of Machiavellianism at a below-average income, $b = 0.45$, $p < .01$.

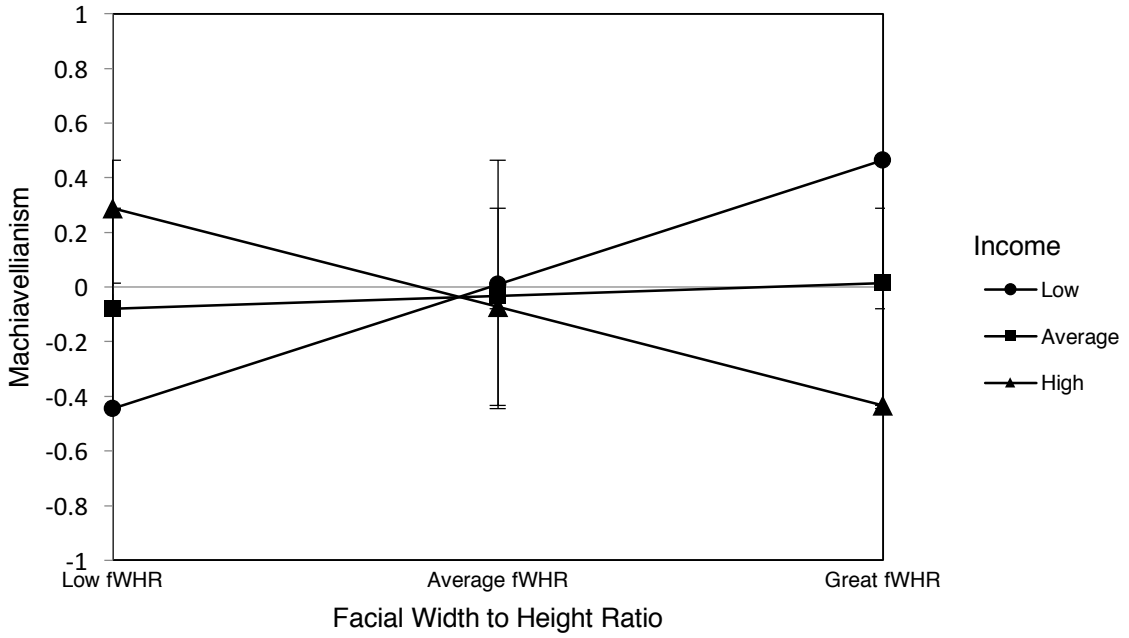

Figure 4. Interaction plot of the relationship between facial width-to-height ratio and Machiavellianism moderated by income.

fWHR was not a significant predictor of narcissism, $b = 0.04$, $p = .71$. The moderator income also did not significantly predict narcissism, $b = 0.19$, $p = .14$. Moreover, the interaction between fWHR and income was not a significant predictor of narcissism, $b = –0.01$, $p = .96$. Likewise, fWHR was not a significant predictor of physical aggression, $b = –0.05$, $p = .70$. The moderator income was a significant predictor of physical aggression, $b = –0.24$, $p < .05$. The interaction between fWHR and income was a significant predictor of physical aggression, $b = –0.37$, $p < .05$. The interaction significantly increased the explained variance in physical aggression, $F(1, 104) = 5.09$, $p = 0.03$, $\Delta R^2 = .06$. This interaction is illustrated in Figure 5. fWHR was a marginally significant predictor of physical aggression at a below-average income, $b = 0.33$, $p = 0.06$, and at an above-average income, $b = –0.42$, $p = 0.07$.

With regard to the other subscales of aggression (verbal, anger, hostility), no significant association either with fWHR or with income was found. Likewise, income did not act as a significant moderator of the relationship between fWHR and these aggression subscales.

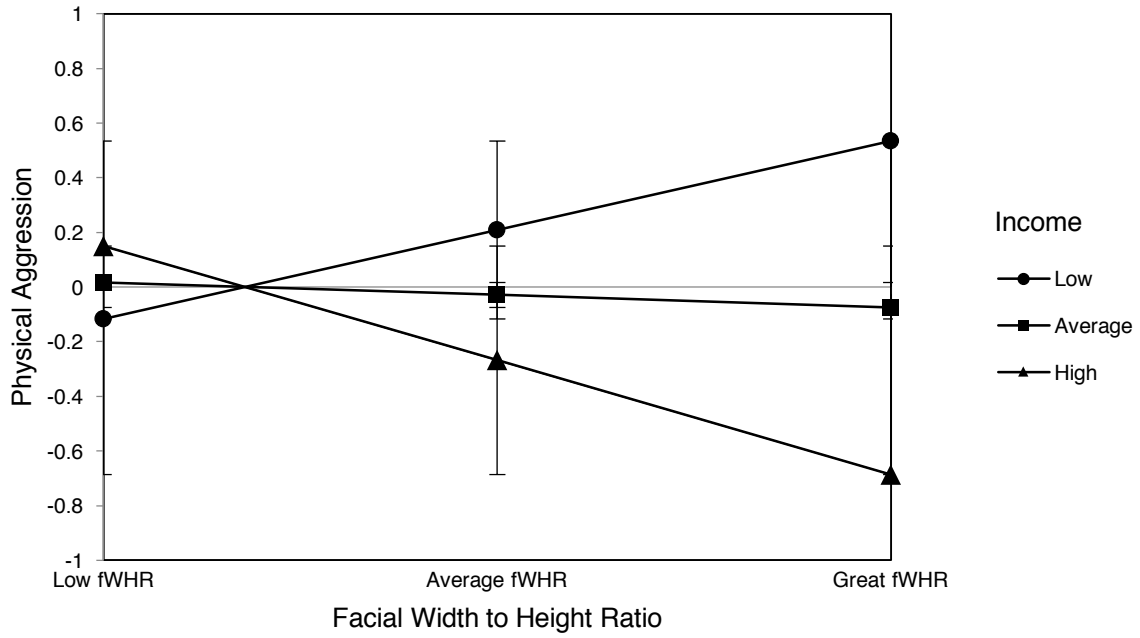

Figure 5. Interaction plot of the relationship between facial width-to-height ratio and physical aggression moderated by income.

8.3.2 Testosterone as a potential moderator

On average, the participants had a salivary testosterone concentration of 67.69 pg/ml (N = 105, SD = 26.58). Correlation analysis showed that salivary testosterone was positively correlated with narcissism (r = 0.22, p = 0.02) but not significantly correlated with fWHR (r = .01). Equally, there was no significant relationship between testosterone and the other subscales of the Dark Triad, Machiavellianism (r = .14) and psychopathy (r = –.06), or between testosterone and aggression (e.g. physical aggression, r = .10).

Next, we tested for the influence of testosterone on the relationship between fWHR and the dependent variables, i.e. the Dark Triad (psychopathy, Machiavellianism, narcissism) and aggression (physical, verbal, anger, hostility). To test the moderating role of testosterone, we conducted separate moderator analyses.

fWHR was not a significant predictor of psychopathy, b = 0.07, p = .58. The moderator testosterone was not a significant predictor of psychopathy, b = –0.05, p = .59. Similarly, the interaction between fWHR and testosterone was not a significant predictor of psychopathy, b = 0.03, p = .76.

fWHR was not a significant predictor of Machiavellianism, b = 0.09, p = .47. The moderator testosterone was a marginally significant predictor of Machiavellianism, b = 0.18, p = .06. The interaction between fWHR and testosterone was a marginally significant predictor of Machiavellianism, b = 0.15, p = .09. The interaction did not significantly increase the explained variance in Machiavellianism, $F(1, 99) = 3.02$, $p = 0.09$, $\Delta R^2 = .02$.

fWHR was not a significant predictor of narcissism, $b = 0.05$, $p = .68$. The moderator testosterone was a significant predictor of narcissism, $b = 0.27$, $p < .01$. Likewise, the interaction between fWHR and testosterone was a significant predictor of narcissism, $b = 0.16$, $p < .05$. The interaction significantly increased the explained variance in narcissism, $F(1, 99) = 4.03$, $p = 0.05$, $\Delta R^2 = .02$.

There was no significant moderation of testosterone in the relationship between fWHR and aggression (physical/verbal aggression, anger, hostility).

8.4 Discussion

The purpose of this study was to investigate the influences of income, as a key marker of social status, and testosterone on the relationship between fWHR and dominance-related traits. The results show that fWHR is positively linked to self-reports of psychopathy, Machiavellianism, and physical aggression, but only at a below-average income. Furthermore, our findings indicate that fWHR is negatively associated with self-reports of physical aggression at an above-average income. Therefore, income was found to be a significant moderator of the relationship between fWHR and physical aggression and of the relationship between fWHR and two Dark Triad traits psychopathy and Machiavellianism. However, income was not a significant moderator of the relationship between fWHR and the other subtypes of aggression (verbal, anger, hostility). Likewise, income did not moderate the relationship between fWHR and the Dark Triad trait narcissism. In contrast to the other Dark Triad traits, narcissism was positively linked to baseline salivary testosterone levels. Furthermore, testosterone was a significant moderator of the relationship between fWHR and narcissism.

The moderating role of income in the relationship between fWHR and physical aggression corresponds to the findings of a previous study (Goetz et al., 2013), thus demonstrating that fWHR is significantly associated with aggression, but only in the context of low income. Our findings extend these previous findings by showing that fWHR is negatively linked to aggression in the context of high income. Furthermore, the results showed that fWHR is linked to the two Dark Triad personality traits psychopathy and Machiavellianism, but only in the context of a below-average income. The moderating role of income in the relationship between fWHR and these dominance-related traits can be explained by the risk sensitivity theory (Welker et al., 2015), which predicts that decision makers prefer high-risk options in situations of high need, when lower-risk options are unlikely to meet those needs (Mishra, Gregson, & Lalumière, 2012). Previous research has indicated that fWHR is part of an evolved cueing system of social dominance, aggression, and power (Geniole et al., 2015). Based on this assumption, men with great fWHRs should display a greater need for power, and consequently perform well in high-status positions (Wong et al., 2011). However, when social status is low, men with great fWHRs should be more likely to engage in behaviors linked to impulsivity and social dominance and in risk-taking behaviors (Welker et al., 2015). In particular, a low income can represent a condition of high need which motivates the preference for risk-seeking strategies (Dohmen et al., 2011; Guiso & Paiella, 2008). This may be because low-income men with great

fWHRs perceive a discrepancy between their high need for power and the current low resources to fulfill their needs. To fill this gap, they are more likely engage in risk-taking strategies such as physical aggression, social manipulation (Machiavellianism), or exploitation (psychopathy) in order to (re-)gain control over highly valued resources such as money. In this case of high need, risk-taking serves as a fast and evolutionary strategy to gain significant immediate and evolutionary benefits. Especially under economically harsh and unstable conditions, such as low income, this risk-taking strategy facilitates the opportunistic and strategic exploitation of one's environment to increase reproductive fitness (Jonason et al., 2012). This would be especially true for low-income men with relatively great fWHRs, who may be more likely to emerge victorious in direct physical altercations (Stirrat, Stulp, & Pollet, 2012; Zilioli et al., 2015). Moreover, risk-taking can constitute an effort to close the gap between low income and great fWHR.

However, fWHR was not linked to the other three subtypes of aggression, namely verbal aggression, anger, and hostility, independently of income, which confirms the findings of a previous study which used the same aggression measure but did not control for BMI (Oezener, 2012). By contrast, Lefevre et al. (2014) reported associations of fWHR with physical aggression, verbal aggression, and anger, but not hostility. It is important to note that none of these studies took into account relevant influencing factors such as income, which might explain the inconsistent findings. The present findings showed that when controlling for BMI, fWHR is associated with physical aggression at a relatively low income only. In comparison to the other aggression subtypes, physical aggression is a direct and the most sexually dimorphic aggressive strategy (Bailey & Hurd, 2005). As men with greater fWHRs have a better physical formidability and fighting ability (Zilioli et al., 2015), they rather apply physical aggression as a risk-taking strategy. This strategy is more advantageous for them because they are more likely to emerge victorious in direct physical altercations.

Previous studies assumed testosterone to be the potential underlying mechanism of links between fWHR and dominance-related traits (Carré & McCormick, 2008; Lefevre et al., 2013). The present findings showed that fWHR was not associated with baseline testosterone. This contradicts the findings of Lefevre et al. (2013), who demonstrated a small positive correlation between fWHR and baseline testosterone. However, a recent analysis across seven diverse samples of men demonstrated no significant positive relationship between fWHR and baseline testosterone (Bird et al., 2016). The authors recommended the use of BMI as a control variable in future studies. In the present analyses, BMI was strongly correlated with fWHR (r = 0.46, p < .00) and was therefore entered as a control variable. The non-significant results of the present study and of the analysis by Bird et al. (2016) suggest that fWHR does not reliably map onto testosterone levels in adulthood. fWHR-neuroendocrine links in men seem to be highly heterogeneous and are therefore apparently not the sole explanatory mechanism for the link between fWHR and dominance-related traits in men. It is plausible that fWHR is more closely tied to testosterone exposure in adolescence: The link between fWHR and dominance-related behaviors and traits might arise due to the common influence of testosterone on the craniofacial growth and the expression of behaviors and traits as part of sexual differentiation in puberty (Carré & McCormick, 2008). Indeed, administration of testosterone to males

with delayed puberty affects various indices of craniofacial growth (Verdonck, Gaethofs, Carels, & de Zegher, 1999). Furthermore, pubertal testosterone can bring about long-lasting effects on behavior and personality (Berenbaum & Beltz, 2011). These findings provide indirect support for the assumption that fWHR and associated dominance-related traits may be more closely tied to pubertal testosterone exposure than to circulating concentrations in adulthood.

Likewise, aggression was also unrelated to baseline testosterone. With regard to previous research, meta-analytic data showed a positive but weak association (r = .08) between testosterone levels and aggression (Archer, Graham-Kevan, & Davies, 2005). However, only three studies investigating the relationship between testosterone and aggression in men older than 35 years were included in this meta-analysis. Moreover, with the exception of the Massachusetts Male Aging Study, with N = 1679 participants (Gray, Jackson, & McKinlay, 1991), the included studies had relatively small sample sizes (N < 16). The correlation coefficient between testosterone and aggression (anger-out) in the Massachusetts Male Aging Study (r = .02) is comparable to that between testosterone and physical aggression in the present sample (r = .01). The non-significant results in the present study can be explained in two ways. First, the challenge hypothesis (Archer, 2006) states that testosterone levels rise only in direct response to challenges. Indeed, Lefevre et al. (2013) found positive associations between fWHR and testosterone reactivity following exposure to potential mates. Second, the present study assessed physical aggression as a general trait of aggressiveness by self-report. It is plausible that objective measures of aggression are more closely linked to testosterone levels in men. For instance, high testosterone levels in male prisoners were linked to a history of rape, murder, and armed robbery (Dabbs, Carr, Frady, & Riad, 1995). It is also important to note that testosterone is not a specific biomarker for aggression but rather for social dominance in general (Eisenegger, Haushofer, & Fehr, 2011).

Regarding the Dark Triad, only narcissism was significantly associated with baseline testosterone. This is in line with the only previous study so far to have investigated the Dark Triad traits and testosterone (Pfattheicher, 2016): A correlation analysis between testosterone and narcissism revealed a significant coefficient of r = .18, which is similar to the coefficient of r = .22 in the present sample. In both studies, no significant relations emerged for psychopathy or Machiavellianism. The present results extend the existing findings by showing that testosterone moderated the relationship between fWHR and narcissism. In contrast, income moderated the relationship between fWHR and the other Dark Triad traits Machiavellianism and psychopathy. Our findings confirm the assumption that the Dark Triad personality traits clearly overlap (see Table 2) but that they differ on a bio-psychosocial basis. Previous research suggested that narcissism is unique, while Machiavellianism and psychopathy are uniform and united as the "Malicious Two" (Jonason, Li & Buss, 2010; Jonason et al., 2012; Veselka, Schermer, & Vernon, 2012). Narcissism's unique contribution to the Dark Triad may lie in its strong sense of entitlement ("I tend to expect special favors from others", "I tend to want others to pay attention to me") and grandiosity ("I tend to want others to admire me", "I tend to seek prestige or status") (Jonason et al., 2012). Grandiosity refers to a highly unrealistic sense of superiority - a sustained view of always being better than others - and is

rather an overt presentation of grandiose fantasies than a realistic assessment of actual circumstances. In this sense, grandiosity means "the more the better", and consequently, successes achieved are never enough. There is never sufficient achievement or material objects (such as money) to match the internal image of grandiosity. Thus, the present findings suggest that the risk-sensitivity theory applies differently for narcissism: Men scoring high on narcissism do not only seek status and prestige at a low income; rather, they have a high need for infinite superiority at all levels of social status. Moreover, the present findings suggest that testosterone is linked to narcissism by regulating the high need for superiority. The results also show that the interaction between fWHR and testosterone is positively associated with narcissism. This simultaneous impact of fWHR and testosterone on narcissism can be explained by their common overlap with superiority and alpha status in men, which fits with the concept of subclinical narcissism.

8.4.1 Limitation and Future Direction

There are some limitations of our study. First, due to the cross-sectional design, our results cannot be interpreted in terms of causal directionality. However, the presumed causal directions are the most theoretically plausible. Longitudinal studies are needed to investigate, for instance, how fWHR affects the way in which people migrate through social hierarchies or how it impacts social relationships in the long term. Second, the sample did not include women. Previous research has predominantly found psychological and behavioral associations with fWHR in men rather than in women (e.g. Carré & McCormick, 2008; Stirrat & Perrett, 2010; Haselhuhn & Wong, 2011). The assessment of testosterone is also more reliable in men (Booth, Granger, Mazur, & Kivlighan, 2006). Moreover, social status was found to moderate the relationship between fWHR and aggression in men but not in women (Goetz et al., 2013). Future research will be required to assess the extent to which fWHR and its interaction with income map onto other trait and behavioral outcomes in women. Third, because aggression and the Dark Triad rely exclusively on self-report measures, they suffer from the same shortcomings that limit all self-report findings (e.g. socially desirable responding). Nonetheless, research has shown that subjective ratings are relevant in predicting outcomes (DeSalvo, Bloser, Reynolds, He, & Muntner, 2006; Rasmussen, Scheier, & Greenhouse, 2009). For instance, the Dark Triad traits represent valid predictors of antisocial behavior (Jones & Figueredo, 2013; Paulhus & Williams, 2002). Moreover, a meta-analysis showed that computerized surveys, as applied for the present study, generate the most truthful responses (Gnambs & Kaspar, 2015). Therefore, we encourage the use of subjective measurements in future research. Future research may add objective measures, such as observations of aggression and social interactions, to investigate the influence of fWHR on dominance-related behaviors.

8.4.2 Conclusion

This is the first study to show that income and testosterone have different influences on the relationship between fWHR and self-reports of dominance-related traits. fWHR is associated with physical aggression and the Dark Triad traits psychopathy and Machiavellianism, but only at a low

income. In contrast, testosterone influences the relationship between fWHR and the Dark Triad trait narcissism. Although narcissism strongly overlaps with psychopathy and Machiavellianism, it is the only Dark Triad trait to be associated with baseline testosterone. To conclude, the findings of the present study represent a contribution to and an extension of research on fWHR and dominance-related traits. They highlight the importance of considering social and neuroendocrine factors when examining associations between fWHR and individual differences in complex human behavioral traits. The findings also provide a basis for future research in order to gain a better understanding of antisocial behavior.

9. Are Psychosocial Resources associated with Perceived Facial Aging in Men?

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9.1 Introduction

It is common to intuitively estimate the age of another person based on their facial appearance. This "perceived age" significantly affects how we evaluate, approach, and interact with others (Voelkle, Ebner, Lindenberger, & Riediger, 2012). As when forming first impressions, only the most accessible information about another person is processed. In this respect, it is common to evaluate or even stereotype people based on their facial appearance (Hehman, Leitner, & Freeman, 2014; Kotter-Grühn & Hess, 2012). Commonly, age-based stereotypes tend to associate younger age with more positive and older age with more negative characteristics. Whereas positive characteristics are assigned to younger adults (e.g., hard-working, impressive, efficient), particularly negative physical characteristics were ascribed to older adults, such as being fragile, tired, or sick (Gruehn, Gilet, Studer, & Labouvie-Vief, 2011). As described by Ferguson (1980), the widespread conception that aging means decline and poor health can become a self-fulfilling prophecy, which might have considerable consequences for the affected individuals. Indeed, negative age stereotyping has been shown to have adverse effects on the performance capacities and well-being of older individuals (Hess, Auman, Colcombe, & Rahhal, 2003; Meisner, 2012; Rothermund, 2005). Consequently, it might be beneficial to look younger than their chronological age especially for older individuals, because their social interactions may be less inflicted by negative age stereotypes.

Perceived age seems to be predictive of longevity beyond subjective and objective health status, and cognitive ability (Dykiert et al., 2012; Gunn, Larsen, Lall, Rexbye, & Christensen, 2016). Furthermore, perceived age has been shown to be a valid biomarker for healthy aging and a strong survival predictor of twins aged more than 70 years (Christensen et al., 2009). In this study,
perceived age correlated with functional and molecular aging phenotypes such as physical and cognitive functioning and leukocyte telomere length. Shorter telomere length is associated with diseases related to aging, individual lifestyle factors, and mortality (Deelen et al., 2014). The co-twin study also showed that 40% of the variation in perceived age is due to nongenetic factors (Christensen et al., 2009). Therefore, it is assumed that lifestyle factors can have significant long-term effects on perceived age (Gunn et al., 2015). In particular, a high social status, being married,

nonsmoking, and describing no depressive mood are significantly associated with a younger appearance in comparison with chronological age from a facial photograph (Rexbye et al., 2006).

To date however, it is still unknown whether and how perceived age is influenced by specific psychosocial resource factors. In particular, optimism, self-esteem, and relationship satisfaction are among the most important psychosocial resources in mental health and are highly interrelated.

Optimism, defined as generalized positive outcome expectancies, has been consistently shown to be an important internal resource for adjusting mental and physical health (Carver & Scheier, 2014; Colby & Shifren, 2013; Jiang et al., 2014; Rasmussen, Scheier, & Greenhouse, 2009; Steptoe, Wright, Kunz-Ebrecht, & Iliffe, 2006). For instance, people who scored high on optimism were less likely to develop a coronary heart disease (Giltay, Zitman, & Kromhout, 2006; Kim, Smith, & Kubzansky, 2014) and showed lower overall mortality (Brummett, Helms, Dahlstrom, & Siegler, 2006) compared with individuals who scored low on optimism. Avvenuti, Baiardini, and Giardini (2016) suggested that optimism may have a direct effect on the neuroendocrine system and on immune responses, and may have an indirect effect on health outcomes by promoting protective health behaviors. Optimism is strongly associated with self-esteem and this could be explained by a core construct of personal resilience (Mäkikangas, Kinnunen, & Feldt, 2004).

High self-esteem, defined as the individual's relation toward the self, is positively related to different dimensions of subjective well-being (Karatas & Tagay, 2012; Manhas, 2014) and seems to be a protective resource factor against depression and anxiety symptoms (Orth, Robins, Meier, & Conger, 2016; Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995; Sowislo & Orth, 2013). Empirical findings support this assumption as low self-esteem is a key criterion for the identification of a wide range of mental disorders such as major depression, bipolar disorder, and borderline and avoidant personality disorders (Orth, Robins, & Meier, 2009; Thoits, 2013).

Bringing optimism and self-esteem together, several studies found that individuals with low optimism and low self-esteem experience greater distress and use more avoidant coping strategies to manage stressful events (Mäkikangas & Kinnunen, 2003). By contrast, high optimism and high self-esteem are key elements of resilience (Wu et al., 2013), which is defined as the capacity and dynamic process of adaptively overcoming stress and adversity while maintaining normal psychological and physical functioning (Russo, Murrough, Han, Charney, & Nestler, 2012).

Likewise, findings from large-scale longitudinal studies strongly indicate that positive interpersonal relationships are important factors of resilience (Burt & Paysnick, 2012). The majority of individuals evaluate romantic relationships as the most intimate adult relationship they experience and as their primary source of affection and support (Levinger & Huston, 1990). Moreover, a satisfying marriage or close relationship has been identified as one of the most important goals in life (Roberts & Robins, 2000). Therefore, the quality of intimate relationships is likely to be an important resource factor in the individual's mental health. There is research showing that greater relationship discord is associated with broad categories for mood, anxiety, and substance-use disorders (Whisman, 2007). Longitudinal research indicated that low relationship satisfaction predicts increases in depression symptoms over time (Whisman & Uebelacker, 2009). In contrast, higher relationship satisfaction is

related to lower perceived stress, less depressive mood, reduced cortisol levels, and higher life satisfaction (Ditzen, Hoppmann, & Klumb, 2008; Fuller-Iglesias, 2015). In addition, subjects describing high relationship satisfaction show better physical (Robles, Slatcher, Trombello, & McGinn, 2014) and mental health (Bradbury, Fincham, & Beach, 2000; McShall & Johnson, 2015; Proulx, Helms, & Buehler, 2007; Whisman & Baucom, 2012) compared with subjects reporting low relationship satisfaction.

Relationship satisfaction has been associated with both optimism (Carver, Scheier, & Segerstrom, 2010; House, Landis, & Umberson, 1988; Smith, Pukall, & Chamberlain, 2013; Srivastava, McGonigal, Richards, Butler, & Gross, 2006) and self-esteem (Erol & Orth, 2014; Hendrick, 1988; Lavner, Karney, & Bradbury, 2013; Vorauer & Quesnel, 2013). Individuals with higher levels of optimism indicated higher relationship satisfaction (Srivastava et al., 2006). Simultaneously, higher initial levels of self-esteem predicted higher levels of relationship satisfaction and positive changes in self-esteem led to an increase in relationship satisfaction (Erol & Orth, 2014).

Taken together, these findings provide evidence that optimism, self-esteem, and relationship satisfaction are important psychosocial resource factors for mental health. Mental health is conceived as a syndrome of subjective well-being consisting of positive feelings toward life and positive functioning in life. Mental health is a protective factor against, while psychological distress or mental illness is a risk factor for, biological and cellular aging (Lindqvist et al., 2015; Verhoeven et al., 2014). Cellular aging, operationalized by shortened leukocyte telomere lengths, is also closely linked to an older appearance (Christensen et al., 2009). As mental health is a protective factor against cellular aging, it might also be a potential protective factor against facial aging.

The purpose of the present study was to examine whether the psychosocial resource factors for mental health, namely optimism, self-esteem, and relationship satisfaction, are associated with perceived age. As optimism, self-esteem, and relationship satisfaction are shown to be highly interrelated and protective psychosocial resource factors in mental health, we hypothesize that these psychosocial resources might have buffering effects through mental health on perceived facial aging in men.

9.2 Methods

The study has a cross-sectional design and is part of a larger research project which focuses on healthy aging in men (Walther, Philipp, Lozza, & Ehlert, 2016).

9.2.1 Participants and Procedure

In the study, a total of 271 men provided psychometric and biological data. The sample size was determined with G-Power calculation (G*Power, Version 3.1.3, Faul, Erdfelder, Buchner, & Lang, 2009). For ANOVA with fixed effects, main effects, and interactions, a priori effect sizes were estimated to reach medium (f^2 = .15) to large (f^2 = .35) effects based on prior moderation analyses with this dataset (Walther, Mahler, Debelak, & Ehlert, 2017). For an effect size of f^2 = .25, alpha error of .05, numerator df = 5, and two groups, a power of .90 would be achieved with a sample size of 270.

The final sample size of N = 271 provided a good powered (.902) analysis. All participants were recruited among the general population. The study was advertised online and via flyers that were distributed. Inclusion criteria, in addition to male gender and age between 40 and 75 years, were no self-reported mental and physical illnesses. The sample exclusively consisted of participants who reported to be in a close relationship (N = 223). In the following, the procedures and measures used in the present study are described. First, online questionnaires were completed to assess the psychosocial resource factors and mental health. Second, participants had a frontal face photograph taken with a digital camera in the laboratory. To achieve comparable photographs, the participants were instructed to maintain a neutral facial expression while standing upright in front of a white background. Informed consent was obtained from all participants before completing the measures. The local Ethics Committee of the Faculty of Arts at the University of Zurich approved the study protocol before data collection.

9.2.2 Measures

Perceived age. Five female raters, aged 41 to 70 years, with a mean age of 55.00 (SD = 11.51), estimated the age of each participant from a face photograph on a scale from 0 to 100 years. The assessors had no prior experience with age assessment. They were not informed about the age range of the participants beforehand. The assessments were conducted via presentation of the photographs on a computer screen. The sequence of photographs was randomly generated to reduce variance between age ratings. To increase reliability, the scores from the five raters were averaged. The mean estimate of the age for each participant was used as the participant's perceived age. The method used for generating perceived age has been tested in terms of its reliability and validity previous to this study (Gunn et al., 2015; Gunn et al., 2008; Gunn et al., 2009). In this study, the perceived age rating had a Cronbach's alpha of α = .97, representing excellent interrater reliability.

Dispositional optimism (Life Orientation Test–Revised [LOT-R]). The German version of the LOT-R (Scheier, Carver, & Bridges, 1994), developed by Glaesmer, Hoyer, Klotsche, and Herzberg (2008), is a 10-item (three target items for each optimism and pessimism, four filler items) self-report measure of individual differences in dispositional optimism and pessimism. Items were rated from 1 (strongly agree) to 5 (strongly disagree). In the present study, only the optimism scale was used. Target items for optimism are "In uncertain times, I usually expect the best," "I'm always optimistic about my future," and "Overall, I expect more good things to happen to me than bad." Scale scores are the sum of items, including reverse coding of the relevant items. Raw scores range from 3 to 15, with higher scores reflecting higher optimism. In a validation study (Glaesmer et al., 2008), internal consistency for optimism was α = .69. In this sample, Cronbach's alpha coefficient for optimism was α = .62, suggesting questionable internal consistency.

Self-esteem (Multidimensional Self-Esteem Scale [MSES]). The MSES (Schütz & Sellin, 2006) is the German adaptation of the Multidimensional Self-Concept Scale (MSCS) developed by Fleming and Courtney (1984). The MSES consists of 32 items and distinguishes six dimensions: self-

regard, social skills, social confidence, performance self-esteem, physical appearance, and physical abilities. Each subscale consists of five to seven items. In addition, the subscales are combined to form a global self-esteem index, which comprises all dimensions. In this study, the global self-esteem index was used. The 32 items were rated on 7-point scales ranging from 1 (not at all) to 7 (very much) for items measuring intensity and from 1 (never) to 7 (very much) for items measuring frequency. Raw scores range from 32 to 224 with higher scores reflecting higher global self-esteem. In previous research, satisfying indications for internal consistency for global self-esteem have been obtained (Daig, Gunzelmann, & Brahler, 2008; Rentzsch, Wenzler, & Schütz, 2016). Cronbach's alpha for global self-esteem in the present sample was α = .80, suggesting good internal consistency.

Relationship satisfaction (Relationship Assessment Scale [RAS]). The German version of the RAS (Hendrick, 1988; developed by Sander & Böcker, 1993) is a seven-item measure for the assessment of relationship satisfaction. The RAS is rated on a 5-point scale. Two items are scored reverse. Mean scores range from 1 (low satisfaction) to 5 (high satisfaction). The reliability and validity of the German version of the RAS have been established in several studies (Sander & Böcker, 1993). In the present study, the Cronbach's alpha for relationship satisfaction was α = .93, suggesting excellent internal consistency.

Mental health (Short-Form 36 [SF-36]). The validated German version of the SF-36 Health Survey (Bullinger, Kirchberger, & Ware, 1995) generates eight bio-psychosocial domains of health-related quality of life. The eight subscales can be categorized in two dimensions: physical health (Physical Function, Physical Role, Bodily Pain, and General Health) and psychological health (Vitality, Social Functioning, Emotional Role, and Mental Health). In the present study, only the Mental Health subscale was of relevance. The Mental Health subscale, derived from the Psychological General Well-Being (PGWB) schedule, consists of five items that cover four major mental health dimensions: depression, anxiety, loss of behavioral or emotional control, and psychological well-being (Ware & Sherbourne, 1992). It includes a mixture of mental symptoms and psychological well-being items to prevent a ceiling effect, when used in general population studies (Bech, Olsen, Kjoller, & Rasmussen, 2003). The Mental Health subscale is transformed into a scale from 0 (lowest possible state) to 100 (best possible state). Previous research indicated an internal consistency of α = .81 in terms of the Cronbach's alpha coefficient (Friedman, Heisel, & Delavan, 2005). In the present study, the Cronbach's alpha for mental health was α = .80, thus suggesting good internal consistency.

9.2.3 Analysis

Statistical analyses included several steps and were performed using the IBM Statistical Package for the Social Sciences (SPSS Version 22). Associations between the main study variables were analyzed by using bivariate and partial correlations. To examine whether mental health mediated the relation between the psychosocial resources (optimism, self-esteem, and relationship satisfaction) and a younger appearance, mediation analysis was conducted using PROCESS (Hayes, 2013). However, the preliminary regression analyses reported below did not show a significant relationship

between two predictors (optimism, self-esteem) and the outcome (difference age [DA]). Preacher and Hayes (2004) argued that indirect effects might still exist despite the non-significant relationship between predictor and outcome. According to the authors, the relation between predictor and mediator and between the mediator and outcome must be significant only. This applies to the present data.

To further analyze the overall indirect effects of the psychosocial resources on perceived age, a structural equation model was developed using AMOS 22.0. In mediation analysis, the direct effects of the predictors (optimism, self-esteem, and relationship satisfaction) on the outcome (younger appearance) became non-significant. Therefore, the indirect effects of these predictors were included in the further structural equation model analysis exclusively.

Analyses were conducted using the bootstrapping method with bias-corrected confidence estimates (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2004). In this study, the 95% confidence interval of the indirect effects was obtained with 5,000 bootstrap resamples (Preacher & Hayes, 2008). Body mass index (BMI), education, income, and smoking were entered as control variables.

9.3 Results

9.3.1 Descriptive Analysis

The age of the sample ranged from 40 to 75 years, with a mean of 57.19 years (*SD* = 10.84). The participants had on average a BMI of 25.42 (*SD* = 3.05). In terms of education, *n* = 136 participants (60.7%) attained primary and secondary qualifications, 88 (39.3%) attained tertiary qualifications. The annual gross income was for *n* = 105 (46.7%) below and for *n* = 120 participants (53.3%) above 100,000 Swiss francs. The majority of the participants were nonsmokers (*n* = 182, 81.3%), *n* = 23 participants (10.3%) described themselves as occasional smokers, and *n* = 19 participants (8.4 %) reported to be regular smokers.

9.3.2 Correlation Analysis

The mean of the perceived age (*M* = 58.10, *SD* = 11.93) was close to the mean of the chronological age (*M* = 57.17, *SD* = 10.86) and these parameters were strongly correlated, $r(221) = .92$, $p < .001$. Due to their high correlation, the difference between participant's chronological age and perceived age (DA = perceived age – chronological age) was used for further analyses. A higher value (above zero) in this variable implies an older appearance whereas a lower value (below zero) reflects a younger appearance in comparison with chronological age. The raters overestimated the age of the participants by an average of 0.93 years (*SD* = 4.66, MIN = –9.80, MAX = 13.00). Descriptive statistics and intercorrelations for the relevant variables are presented in Table 3. DA significantly correlated with optimism, relationship satisfaction, and mental health. Mental health significantly correlated with optimism, self-esteem, and relationship satisfaction. No correlation exceeded .70; thus, the assumption of multicollinearity was not violated.

Table 3. Descriptive statistics and intercorrelations among the relevant variables

	Mean	*SD*	1	2	3	4	5
1. Difference age (DA)	0.93	4.66	1.00	–0.12*	–0.03	–0.14**	–0.17**
2. Optimism	9.41	2.02	–0.12*	1.00	0.52**	0.26**	0.39**
3. Self-esteem	177.64	21.59	–0.03	0.52**	1.00	0.28**	0.52**
4. Relationship satisfaction	4.18	0.72	–0.14**	0.26**	0.29**	1.00	0.32**
5. Mental health	75.43	12.49	–0.17**	0.39**	0.52**	0.32**	1.00

Note. Control variables: BMI, income, education, and smoking.

SD: standard deviation.

$N = 223$; significance levels (one-tailed): * $p < .05$, ** $p < .01$.

9.3.3 Mediation Analysis

Next, we were interested in the mediating effect of mental health in the relation between the predictors (optimism, self-esteem, relationship satisfaction) and the outcome (DA). Mediation analyses confirmed the significant relationships between predictors and mediator and between mediator and outcome. Moreover, they provided evidence for the mediating role of mental health.

Optimism was not a significant predictor of DA, $b = –0.27$, $t(217) = –1.72$, $p = .09$. Optimism was a significant predictor of the mediator mental health, $b = 0.61$, $t(217) = 6.28$, $p < .001$. The mediator mental health, controlling for optimism, was significantly related to DA, $b = –0.22$, $t(216) = –2.07$, $p < .05$. Optimism, controlling for the mediator, was not a significant predictor of DA, $b = –0.13$, $t(216) = –0.79$, $p = .43$. The bootstrapped unstandardized indirect effect was $b = –0.14$. The 95% confidence interval ranging from –0.30 to –0.02 did not include zero, thus the indirect effect was statistically significant and mediation occurred (Preacher & Hayes, 2004).

Self-esteem was not a significant predictor of DA, $b = –0.01$, $t(217) = –0.37$, $p = .71$. Self-esteem was a significant predictor of the mediator mental health, $b = 0.08$, $t(217) = 9.00$, $p < .001$. The mediator mental health, controlling for self-esteem, was significantly related to DA, $b = –0.33$, $t(216) = –2.81$, $p < .01$. Self-esteem, controlling the mediator, was not a significant predictor of DA, $b = 0.02$, $t(216) = 1.15$, $p = .25$. The bootstrapped unstandardized indirect effect was $b = –0.03$. The 95% confidence interval ranging from –0.04 to –0.01 did not include zero, giving evidence for the mediating role of mental health.

Relationship satisfaction was significantly related to DA, $b = –0.90$, $t(217) = –2.07$, $p < .05$. Relationship satisfaction was a significant predictor of the mediator mental health, $b = 1.39$, $t(217) = 4.93$, $p < .001$. The mediator mental health, controlling for relationship satisfaction, was significantly related to DA, $b = –0.21$, $t(216) = –2.04$, $p < .05$. Relationship satisfaction, controlling for the mediator mental health, became an nonsignificant predictor of DA, $b = –0.61$, $t(216) = –1.33$, $p = .18$. The

bootstrapped unstandardized indirect effect was $b = -0.29$. The 95% confidence interval ranging from −0.66 to −0.02 did not include zero, thus the indirect effect was statistically significant and mediation can be assumed (Preacher & Hayes, 2004).

9.3.4 The Structural Equation Model

To test the indirect effects of the psychosocial resources (optimism, self-esteem, and relationship satisfaction) on DA via mental health in an overall model, we applied structural equation modeling. The model contained one endogenous variable (DA) and four exogenous variables (optimism, self-esteem, relationship satisfaction, and mental health). The results showed that the model goodness of fit was excellent: $\chi^2(3, N = 223) = 5.017$, $p = .17$; root mean square error of approximation (RMSEA) = 0.055 [0.000, 0.137]; standardized root mean square residual (SRMR) = .0293; Tucker–Lewis index (TLI) = 0.963; and comparative fit index (CFI) = 0.989. The results confirmed the mediating role of mental health in the relation between the psychosocial resources and DA. The direct and indirect effects of the overall model are presented in Table 4.

Table 4. Direct and indirect effects and 95% confidence intervals for the overall structural equation model

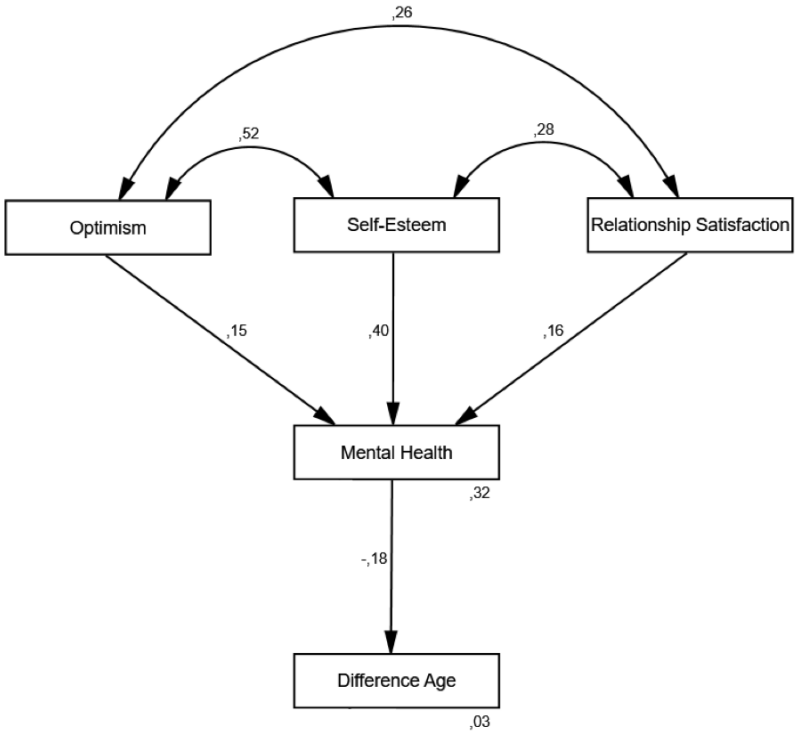
		95% Confidence interval		
	B	Lower bound	Upper bound	*p*
Direct effects:				
OPT → MH	0.147	0.013	0.285	0.034
SE → MH	0.404	0.263	0.527	0.001
RS → MH	0.162	0.039	0.279	0.009
MH → DA	−0.177	−0.308	−0.047	0.008
Indirect effects:				
OPT → MH → DA	−0.026	−0.074	−0.003	0.022
SE → MH → DA	−0.071	−0.133	−0.022	0.006
RS → MH → DA	−0.029	−0.073	−0.005	0.009

Note. $N = 223$. Control variables: BMI, income, education, smoking.
OPT: optimism, SE: self-esteem, RS: relationship satisfaction, MH: mental health,
DA: Difference Age (perceived age − chronological age).

The indirect effect of optimism on DA was $b_{stand} = -0.026$ [−0.074, −0.003], $p < .05$. In the same model, the indirect effect of self-esteem on DA was $b_{stand} = -0.071$ [−0.133, −0.022], $p < .01$, and the indirect effect of relationship satisfaction on DA was $b_{stand} = -0.029$ [−0.073, −0.005], $p < .01$. The standardized regression weights indicate small to medium effect sizes within the model (Cohen,

1990). The overall model accounted for 32% variance in mental health and 3% variance in DA. The control variables were statistically not significant. The factor loadings remained significant after controlling for BMI, education, income, and smoking. The structural equation model including all significant variables is shown in Figure 6. Taken together, these results show that mental health is a considerable mediator in the relation between the psychosocial resources and DA.

Figure 6. Structural Equation Model ($N = 223$). Factor loadings are standardized ($p < .01$).



9.4 Discussion

To our knowledge, this study demonstrated for the first time that psychosocial resources are indirectly associated with a younger facial appearance. Mental health mediated the relation between these psychosocial resources and perceived age. Optimism, self-esteem, and relationship satisfaction were strong predictors of mental health which was significantly associated with a younger facial appearance in healthy men.

The findings confirm the meaningful role of optimism, self-esteem, and relationship satisfaction for mental health functioning (e.g., Carver & Scheier, 2014; Fuller-Iglesias, 2015; Karatas & Tagay, 2012). Optimism and self-esteem are highly intercorrelated, forming the core construct of resilience (Mäkikangas et al., 2004). In comparison of effect sizes, self-esteem exhibited the strongest influence on mental health. This fits with recent findings, showing that self-esteem acts as a protective factor for depression and anxiety (Rosenberg et al., 1995; Sowislo & Orth, 2013). Optimism and relationship satisfaction had beneficial effects of similar magnitudes on mental health, thus showing

that generalized positive outcome expectancies and satisfying romantic relationships are of central importance for mental health.

Furthermore, the findings of this study revealed that mental health was significantly related to a younger facial appearance. Specifically, the difference between chronological age and perceived age seems to play an important role in terms of mental health. The results point out the importance for the promotion of mental health in men older than 40 for the maintenance of good health and the deceleration of perceived facial aging. A younger appearance enhances the likelihood to be associated with more positive age-based stereotypes and, becoming a self-fulfilling prophecy, looking younger leads to higher performance capacities and higher psychological well-being (e.g., Hess et al., 2003; Meisner, 2012; Rothermund, 2005). Likewise, younger looking individuals might be more socially integrated and supported, which again can have positive impacts on their health. Accordingly, a younger facial appearance has been associated with better physical health and longevity (Christensen et al., 2009).

To our knowledge, this was the first study examining the association of mental health and a younger facial appearance in healthy men. Previous research offers few lines of interpretation for the novel findings regarding the relation between mental health and a younger facial appearance. A study examining cellular aging found links between psychological distress of depression and shortened telomere lengths (Verhoeven et al., 2014). Psychological distress has a large, detrimental impact on the wear and tear of a person's body, resulting in accelerated biological aging and causes a person's telomeres to shorten, leading to enhanced cellular aging. Further on, biological and cellular aging are accompanied by perceived facial aging as well (Christensen et al., 2009). However, mental health can be a protective factor against cellular, biological, and facial aging. Neuroendocrine pathways are assumed to be responsible for the association between mental health and facial aging and need to be examined in future studies.

9.4.1 Limitation and Future Direction

Some limitations of this study should be noted. First, this study was cross-sectional and causal inferences are limited by the design. Therefore, associations between the investigated psychosocial resources, mental health, and perceived age do not point to causality. Longitudinal studies are crucial to understand whether and to what degree changes in perceived age are related to or independent of changes in the psychosocial resources over time. Second, this study was based on a nonexperimental research design, and therefore, the results do not allow for causal explanation. Testing interventions designed to manipulate the psychosocial resources would be preferable to identify underlying mechanisms. Third, all of the psychosocial measures were self-reported, which can generate response bias. To reduce the likelihood of socially accepted answers, the psychometric questionnaires were completed online and encrypted with a personal code. With regard to relationship satisfaction, future work should incorporate dyadic perspectives to assess the mutual dependence inherent in close relationships (e.g. Lewis & Butterfield, 2007). Another limitation, albeit an intentional one, is that the results only apply to self-reporting healthy men between 40 and 75 years. The study

examined the association between psychosocial resources and perceived age in men. According to Oblong (2012), male skin progressively thins with advanced age, whereas postmenopausal female skin undergoes a more rapid thinning of the dermis due to decreasing estrogen levels in menopause. Indeed, declining estrogen levels are associated with a variety of cutaneous changes and facial aging in postmenopausal women (Campbell et al., 2014). To examine the influence of psychosocial resources on facial aging independently of postmenopausal status, we focused in this study on aging men exclusively. Finally, in this sample, the optimism scale of the LOT-R achieved a slightly lower internal consistency than the value found in a validation study (Glaesmer et al., 2008). Nonetheless, the LOT and its revised version are the most widely used instruments for measuring optimism in psychological research (Glaesmer et al., 2012).

Further studies are needed to gain more comprehensive insights into the influence of psychosocial resources for mental health on perceived age. In particular, future research should incorporate longitudinal data collection to examine the long-term beneficial effects of psychosocial resources on perceived age. Nevertheless, this study is the first to link psychosocial resources to perceived facial aging and establishes opportunities to promote mental health functioning in older age.

9.4.2 Conclusion

This research provided initial insight into the association between psychosocial resources and facial aging. Results demonstrated that optimism, self-esteem, and relationship satisfaction are indirectly associated with a younger appearance. Mental health considerably mediated the link between these psychosocial resources and a younger appearance. The findings reveal that important psychosocial resource factors in mental health are linked to a younger appearance, which in return can yield positive effects in daily life.

PART III: GENERAL DISCUSSION

10. Summary of Findings

The findings of the present thesis emphasize the importance of considering bio-psychosocial factors when investigating the relationship between facial appearance and both personality and health. Study I investigated the influence of income, as a key marker of social status, and salivary testosterone on the association between fWHR and self-reported dominance-related traits including aggression and the Dark Triad. In terms of aggression, fWHR was positively associated with physical aggression in men reporting low income. Furthermore, fWHR was negatively associated with physical aggression in men reporting high income. Therefore, the findings indicate income to be a significant moderator of the relationship between fWHR and physical aggression. No associations with fWHR were found for the other subscales of aggression such as verbal aggression, anger, and hostility. With regard to the Dark Triad, fWHR was positively associated with psychopathy and Machiavellianism, but only at a low income. These findings indicate that income moderates the relationship between fWHR and the Dark Triad traits psychopathy and Machiavellianism, in the sense that fWHR is only linked to these personality traits at a low income. By contrast, income did not moderate the relationship between fWHR and the Dark Triad trait narcissism. Furthermore, testosterone was neither associated with fWHR nor with aggression and the Dark Triad traits - except for narcissism. The results further showed a significant interaction of fWHR and testosterone on narcissism; thus, suggesting testosterone to be a moderator of the relationship between fWHR and narcissism. Taken together, these findings provide first evidence for income and testosterone having different influences on the relationship between fWHR and dominance-related traits. The findings also highlight the importance of considering bio-psychosocial factors when examining links between fWHR and individual differences in complex behavioral personality traits.

Study II looked into the relationship between psychosocial resources and perceived facial aging by analyzing whether the psychosocial resource factors for mental health, namely optimism, self-esteem, and relationship satisfaction, are associated with a younger facial appearance. Correlation analyses revealed that optimism, relationship satisfaction, and mental health were associated with a younger facial appearance compared to chronological age. In addition, mental health was associated with each resource factor. Subsequent mediation analyses demonstrated that mental health considerably mediated the relationship between each resource factor and perceived age. Structural Equation Modelling confirmed the indirect associations of optimism, self-esteem, and relationship satisfaction with perceived facial aging. These findings provide the first empirical evidence for the indirect associations between the psychosocial resources and perceived age via mental health. Optimism, self-esteem, and relationship satisfaction were strongly linked to mental health which was significantly associated with a younger facial appearance. Furthermore, the findings indicate that psychosocial resource factors in mental health can yield positive impacts on perceived facial aging.

Taken together, the findings of the two empirical studies increase the knowledge on facial appearance and its association with bio-psychosocial factors in men.

11. Discussion and Integration of Findings

Since ancient times, facial appearance has been used as the source of information about the personality and health of its wearer. Accordingly, at 46 BC, Cicero (1963) composed the proverb "Ut imago est animi voltus sic indices occuli" which can be translated as "The face is a picture of the mind as the eyes are its interpreter". Nowadays, the belief that facial appearance provides information about a person's personality and health, which has been referred to as "kernel of truth", still exists in the people's minds (Hassin & Trope, 2000). From an evolutionary perspective, an appropriate face evaluation is essential for survival: According to the ecological approach to person perception (Gibson, 1979), the function of face evaluation is to provide adaptive information about a specific individual and ensuing to serve adaptive action (Zebrowitz & Montepare, 2006, 2008). Indeed, previous research provided some empirical evidence for this kernel of truth. However, some of the evidence for facial appearance being a valid cue for personality traits and health is still inconclusive. The two empirical studies presented in this thesis emphasized facial appearance and its association with personality and health. Whereas study I investigated the association between facial appearance and dominance-related personality traits, study II focused on the link between facial appearance and psychosocial factors for mental health. Previous research on facial appearance and its association with personality highlights the potential of face shape, particularly the fWHR, to be a valid cue of dominance. However, some studies failed to replicate the link between fWHR and dominance. Research on fWHR and its link to dominance hardly ever considered any confounding and moderating variables. Regarding the link between facial appearance and health, previous research provided evidence for perceived age being a biomarker for healthy aging. However, the literature on psychosocial factors influencing perceived age remains scarce.

In study I, our first result demonstrated that men's fWHR is not directly associated with self-reports of dominance-related traits including subscales of aggression and the Dark Triad. The non-significant finding regarding fWHR and aggression is mostly in line with the two previous studies using the same measure of aggression (Aggression Scale; Buss & Perry, 1992). No significant associations between fWHR and the different subscales of aggression could be found in the study from Oezener (2012). Another study from Lefevre and colleagues (2014) showed that men's fWHR is only associated with the subscale hostility. In terms of the Dark Triad, this was the first study to examine its link with fWHR. Previous studies examined the relationship between fWHR and psychopathic characteristics such as untrustworthiness and exploitation of others (Haselhuhn & Wong, 2011; Jia et al., 2014; Stirrat & Perret, 2010). Furthermore, associations between fWHR and the psychopathic traits fearless dominance (Anderl et al., 2016; Geniole et al., 2014) and self-centered impulsivity as well as overall psychopathy scores were found (Anderl et al., 2016). Given the convergence of literature linking fWHR to dominance-related traits, it seems highly unlikely that all of these findings represent Type 1 error. Rather, specific bio-psychosocial factors seem to be responsible for the variable association between fWHR and social dominance. It is important to note that the majority of the prior studies did not take into account relevant confounding or influencing factors, which might be

responsible for the inconsistent findings. Except for Anderl and colleagues (2016), no study mentioned above controlled for BMI in their analyses. However, BMI seems to be moderately linked to fWHR (r = .31; Geniole et al., 2015) and may therefore confound the relation between fWHR and dominance. For instance, Deaner and colleagues (2012) showed that body weight, but not fWHR, predicts aggression in a sample of professional hockey players. In study I, BMI was closely related to fWHR (r = .46) and therefore controlled for in all analyses. Moreover, no study mentioned above considered social status as potential moderator of the relationship between fWHR and dominance. A high social status is defined as having greater personal resources, such as higher income (Kraus et al., 2012). Although income and education reflect both facets of social status, they reflect distinct bases of hierarchical differentiation (Magee & Galinsky, 2008). Income refers to control over valued resources and is therefore more likely to be linked to dominance and power in comparison with education. Indeed, income but not education predicts unethical behavior (Dubois et al., 2015).

Our second result demonstrated that social status moderated the link between fWHR and the dominance-related traits. Our study provided first empirical evidence that fWHR is positively associated with the Dark Triad traits psychopathy and Machiavellianism - but only in low-income men. Likewise, fWHR exhibits a trend to be positively associated with physical aggression in men reporting low income. By contrast, fWHR tends to negatively associate with physical aggression in men reporting a high income. These findings suggest that "the broader the face - the more dominant" applies exclusively to men with a low income. The findings are in line with previous studies showing that fWHR is only associated with aggressive behavior in low-income men (Goetz et al., 2013) and risk-taking in men reporting low social status (Welker et al., 2015). These consistent findings in research indicate that fWHR is not per se an indicator of dominance, but only when men perceive themselves as being low in social status.

What are the psychological mechanisms through which the constellation of a great fWHR and a low social status might promote dominance? Drawing on the theory of risk sensitivity, decision-makers are expected to prefer high-risk options in situations of high need, when lower-risk options are unlikely to meet those needs (e.g. Mishra et al., 2012). Transferred to the results of social status moderating the link between fWHR and dominance, this theory implies that fWHR may specifically promote dominance in situations of high need where such behavior is advantageous, such as low social status (Welker et al., 2015). In this context, dominance refers to the motivation of an individual to achieve or maintain a high social status (Mazur, 2005). As fWHR is part of an evolved cueing system of dominance, men with great fWHRs are expected to display a greater need for power and status. When social status is high, this need is more likely to be fulfilled and no risk-taking strategies are needed. Indeed, previous studies showed that men with great fWHRs perform well in high-status positions (Geniole et al., 2015). However, when having a low social status, their need for power and status is unsatisfied and this condition of high need leads to the pursue of high-risk strategies to fulfil their need. Accordingly, men with great fWHRs engage in risk-taking strategies such as physical aggression, social manipulation (Machiavellianism), or exploitation (psychopathy) in order to (re-)gain control over highly valued resources such as money. Following a risk-taking strategy under certain

circumstances, such as low social status, may be the only means available to satisfy the need for status (Simon, 1956; Todd & Gigerenzer, 2000). Furthermore, risk-taking can provide benefits in terms of reputational enhancement (Fessler et al., 2014). In this case of high need, risk-taking serves as an efficient strategy with evolutionary advantages by immediately gaining significant benefits. The four possible constellations of fWHR and social status are illustrated in a simplified scheme in Table 5.

Table 5. Four-field scheme illustrating the possible constellations of facial width-to-height ratio and social status

	Small fWHR	Great fWHR
Low Social Status	Low need for power ▸ no risk-taking	High need for power is unsatisfied ▸ risk-taking
High Social Status	Low need for power ▸ no risk-taking	High need for power is satisfied ▸ no risk-taking

The constellation of a great fWHR and a low social status results in a discrepancy between the high need for power and the current low resources to fulfil those needs. This discrepancy fits into the theory of cognitive dissonance (Festinger, 1957). When needs and resources to fulfil the needs clash, a discrepancy is evoked, resulting in a state of tension referred to as cognitive dissonance. As the experience of such dissonance is unpleasant, the individual is motivated to reduce or eliminate it in order to achieve consonance. Consequently, cognitive dissonance can lead to an alteration in the attitudes, beliefs, or behaviors to reduce the discrepancy and to restore balance between the needs and resources. The cognitive dissonance theory also states that a powerful motive to maintain consistency can give rise to irrational and maladaptive behavior. This maladaptive behavior in the form of risk-taking strategies can constitute an effort to reduce the discrepancy between low resources and high need. Perceived discrepancy and its role in risk-taking strategies involving behavioral traits of aggression, Machiavellianism, and psychopathy, is pictured in Figure 7.

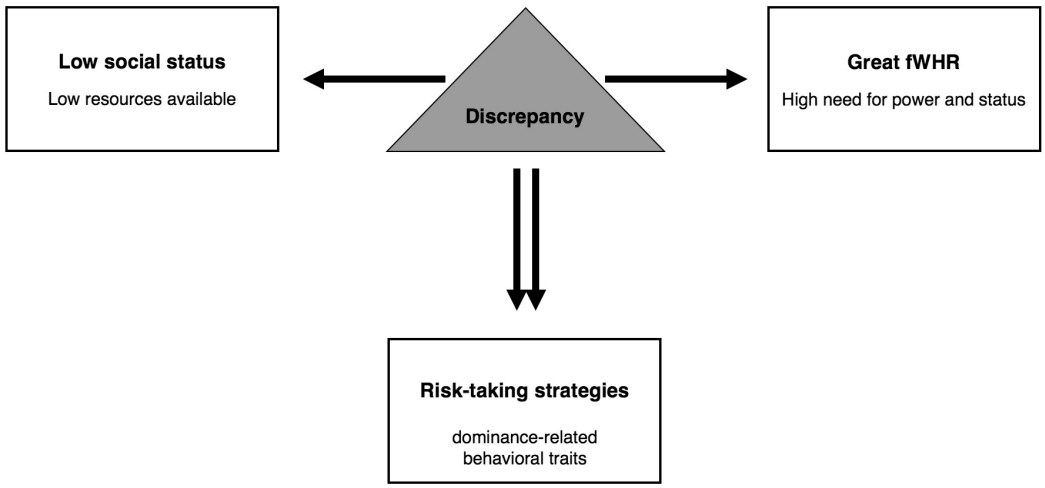


Figure 7. Discrepancy between great facial width-to-height ratio (fWHR) and low social status leads to dominance-related behavioral traits.

Our third result showed that baseline testosterone is not directly linked to fWHR. The missing relationship between fWHR and baseline testosterone is in line with a recent analysis across seven different samples of men (N = 1041) showing no relationship between fWHR and baseline testosterone (Bird et al., 2016). The consistent non-significant results indicate that fWHR does not reliably map onto testosterone levels in adulthood. It is plausible that fWHR is more closely tied to exposure to prenatal or pubertal testosterone due to the common influence of testosterone on the craniofacial growth (Verdonck et al., 1999) and the expression of behavioral traits as part of sexual differentiation (Berenbaum & Beltz, 2011). However, previous studies revealed no significant link between adult fWHR and testosterone exposure during adolescence (Hodges Simeon et al., 2016) or pregnancy (Whitehouse et al., 2015).

Despite the lack of a direct link between fWHR and testosterone, there was a significant interaction of testosterone and fWHR on the Dark Triad trait narcissism. This first empirical evidence of an interaction between fWHR and testosterone on narcissism indicates that the risk-sensitivity theory applies differently to fWHR and narcissism: Narcissism is characterized by a permanent concern about the social standing while being motivated to be superior and better than others (Brown & Zeigler-Hill, 2004). Simultaneously, narcissism is characterized by a vulnerability to interpersonal threats (Twenge & Campbell, 2003). Congruently, men scoring high on narcissism not only seek status and power at a low social status; they rather possess a high need for superiority at all status levels. From this point of view, it makes sense that testosterone but not social status interacts with fWHR on narcissism. The interacting effect of fWHR and testosterone can be explained by their common overlap with superiority and alpha status, which fits with the concept of narcissism. Both fWHR (Carré, Murphy, & Hariri, 2011) and testosterone (Derntl et al., 2009) seem to be linked to an increased amygdala activation in response to signals of interpersonal threat. The amygdala is a brain structure rich in androgen receptors (Rubinow & Schmidt, 1996) and is affected by circulating

androgens (Sarkey, Azcoitia, Garcia-Segura, Garcia-Ovejero, & DonCarlos, 2008). A heightened amygdala reactivity to signals of social threat may represent a plausible neural mechanism linking interactions of fWHR and testosterone to individual differences in narcissism. In study I, testosterone was positively linked to narcissism, which is in line with a previous study (Pfattheicher, 2016). No such relationships could be found for Machiavellianism and psychopathy. These findings support the assumption that the Dark Triad personality traits clearly overlap, but that they differ on a bio-psychosocial basis (Rauthmann & Kolar, 2012, 2013). Overall, the findings of study I highlight the importance of taking important bio-psychosocial factors into account when examining the link between fWHR and dominance-related traits and behaviors.

Study II investigated the role of psychosocial resources in perceived facial aging. Previous research mostly disregarded the influence of psychosocial factors on perceived facial aging, while instead focusing on extrinsic factors such as sun exposure or smoking. Only three studies hitherto were devoted to psychosocial factors, by showing that a low depression score, a high social status, being married (Rexbye et al., 2006), satisfaction with life (Dykiert et al., 2012), and low financial stress (Agrigoroaei et al., 2016) are associated with a younger facial appearance. Our study extends previous research by introducing important psychosocial resources for mental health into this research field. In particular, optimism, self-esteem, and relationship satisfaction play key roles for mental health functioning, as the present and previous research indicate. In study II, these psychosocial resources were strongly linked to mental health. Moreover, they were indirectly associated with a younger facial appearance, mediated by mental health. The findings once again illustrate that mental health is much more than the absence of psychopathology by showing that psychosocial resources, such as optimism, self-esteem, and relationship satisfaction, are important components of mental health. However, there were no studies examining mental health along with perceived facial aging until this point. This study addressed this gap by investigating the role of psychosocial resources in mental health and perceived age. The present findings indicate that the psychosocial resources are indirectly associated with a younger facial appearance, mediated by mental health.

What are plausible underlying mechanisms for psychosocial resources being indirectly associated with a younger facial appearance through mental health? Drawing on the plausible pathways linking positive affect to physical health proposed by Pressman and Cohen (2005), we assume the following two pathways to link mental health to perceived facial aging.

The first pathway addresses the direct impact of mental health on physical health. Individuals reporting negative affective states, such as depression, are exposed to a higher risk of premature mortality as well as coronary heart disease, type 2 diabetes, and disability (Cuijpers & Smit, 2002; Steptoe, Wardle, & Marmot, 2005). Conversely, positive affective states seem to exhibit favorable effects on longevity and health (Huppert, 2009; Pressman & Cohen, 2005). For instance, positive affect was negatively associated with baseline cortisol, ambulatory heart rate, and fibrinogen stress responses (Steptoe & Wardle, 2005; Steptoe et al., 2005). The effects were independent of psychological distress, supporting the notion that positive mental health states can be directly linked

to health-relevant biological processes. Such effects may be particularly relevant in old age, when the accumulation of risk factors leads to increased risk of chronic disease (Steptoe et al., 2005). As perceived facial aging is a valid biomarker for healthy aging and strongly linked to physical health (Christensen et al., 2009), it is very likely that mental health is also related to a better functioning in biological systems relevant for facial aging. Thus, suggesting that mental health can predict a younger facial appearance. However, the pathways mediating such effects remain poorly understood. While popular magazines proclaimed positive affective states such as happiness to improve the physical health for years, this hypothesis has been relatively ignored in research on psychological predictors of health. In their review, Pressman and Cohen (2005) suggested health-related behavior, psychosocial factors, and neuroendocrine and immune responses as possible mediators of the beneficial effects of mental health.

As an alternative to the direct effect, mental health may have beneficial effects on perceived facial aging through its ability to buffer the potentially pathogenic influences of stress. Particularly long-term stress accelerates biological aging as indexed by telomere shortening due to a constant wear and tear on the body (Damjanovic et al., 2007; Epel et al., 2004). A short telomere length reflects stress-related oxidative damage to cells and accelerated aging and has emerged as a potential common biological mechanism linking stress and diseases of aging (Simon et al., 2006). Moreover, a short telomere length has been linked to perceived facial aging (Christensen et al., 2009); thus, indicating that long-term stress accelerates biological aging, including facial aging. Indeed, a recent study showed that financial stress accelerates perceived facial aging (Agrigoroaei et al., 2016). Drawing on the stress-buffering model, the psychosocial resources optimism, self-esteem, and relationship satisfaction can act as protective factors against the adverse effects of stress on biological aging. The psychosocial resources represent key elements of personal resilience and enable individuals to bounce back from adversity, and to adapt, thrive, and mature in the face of adverse circumstances (Friborg, Hjemdal, Rosenvinge, & Martinussen, 2003). Accordingly, they might promote resilience against the detrimental effects of stress.

Taken together, psychosocial factors for mental health can have direct or indirect effects on perceived facial aging. On the one hand, due to the direct link of mental health to health-relevant biological processes, mental health can have direct impacts on perceived facial aging. On the other hand, psychosocial resources for mental health can act as protective factors against the detrimental effects of stress on perceived facial aging.

12. Strengths and Limitations

The two empirical studies presented in this thesis provide new and valuable insights into the association of facial appearance with personality and health. Study I was part of a larger research project investigating risk and protective factors of vital exhaustion in men and consisted of a sample of N = 109 vitally exhausted and self-reporting healthy men aged 40 to 75 years. Study II pertains to a larger research project focusing on healthy aging in men and included a sample of N = 223 self-reporting healthy men aged 40 to 75 years. The empirical studies shared the same study design and similar procedures. First, participants filled in online questionnaires to assess sociodemographic data and the psychosocial constructs. Second, the participants were assigned for the laboratory session to provide biological data and to take the face photograph.

Our recruitment strategies, mainly consisting of online advertisements, distributed leaflets in the Canton of Zurich (Switzerland), and an announcement in a complimentary weekly magazine, enabled us to reach men aged 40 to 75 years with a high variety of socioeconomic backgrounds from the general population of the German part of Switzerland. Due to the economic online setting with only one appointment at the laboratory, the time required for participation could be kept to a very low level. The standardized laboratory setting enabled us to generate face photographs with high quality to assess both fWHR and perceived age. We could guarantee the reliability of the facial measures by comparing the ratings of perceived age between five independent assessors (α = .97) and the ratings of fWHR between two trained and independent assessors (α = .99). Accordingly, the inter-rater reliabilities obtained for both facial cues were excellent.

Furthermore, the two empirical studies comprehensively investigated facial appearance and its association with dominance-related personality traits and psychosocial factors for mental health, respectively. Study I included multiple personality traits in dominance, such as different facets of aggression and the Dark Triad encompassing psychopathy, Machiavellianism, and narcissism. Study II considered optimism, self-esteem, and relationship satisfaction as important psychosocial resource factors for mental health. Consequently, the presented studies introduced some new bio-psychosocial facets into the research field of facial appearance, particularly by shedding light on the associations of facial appearance with dominance-related personality traits and mental health factors.

Nevertheless, the interpretation of the presented findings is restricted by some limitations that require consideration. Due to the cross-sectional design of both studies, no causal inferences can be drawn. Consequently, associations between facial appearance and personality as well between facial appearance and health do not point to causality. Longitudinal studies with prospective or experimental designs are needed to draw reliable conclusions on causality or chronological order.

An additional limit pertains to the external validity of the samples included in the two studies. Although the recruitment strategy and inclusion criteria allowed addressing a substantial part of healthy men aged over 40 residing in Switzerland, the study samples had on average a higher social status, particularly income, compared to both the general Swiss population and the world population. Our recruitment strategy based on voluntary study participation without any monetary compensation,

which is likely to have resulted in a selection bias. It is plausible that particularly men with a relatively high social status and a high commitment to their health felt targeted and were therefore overrepresented in the study samples. Furthermore, due to the importance of environmental and sociocultural factors on facial appearance, personality traits, and health, our findings might not be generalizable to other sociocultural backgrounds. Consequently, the presented findings might be limited to men with relatively high social status living in societies with stable economic and social conditions.

Furthermore, a limitation refers to the assessment of the personality traits and psychosocial resources. All of these psychosocial factors were assessed with questionnaires based on self-reports, which can produce biases. For instance, self-report questionnaires rely on the honesty of the participants. In particular, sensitive questions regarding socially undesirable behaviors, such as aggression or deception, can increase the risk of socially desirable answers. Nonetheless, research has shown that computerized surveys, as applied in both empirical studies, generate the most truthful responses (Gnambs & Kaspar, 2015). However, even if the participants are honest, their introspective ability may be insufficient to provide an accurate response. Furthermore, self-reports collected at a single point of time are limited by recall bias and are not well suited to address how personality traits and health change over time and across contexts. Future research should increasingly apply ecological momentary assessment which is more suitable for reliably assessing psychosocial factors with self-reports by minimizing recall bias and maximizing ecological validity. Furthermore, a momentary assessment allows the analysis of micro processes affecting behavior in real-world contexts (Shiffman, Stone, & Hufford, 2008). Future research may also add more objective measures, such as the observation of specific behavior or social interactions.

Finally, specifically concerning study II, important influencing factors on perceived age identified by previous research were not considered. In particular, sun exposure, as one of the strongest accelerators of facial aging, was not included as a control variable. Previous studies assessed sun exposure by a single item assessing whether the main activity at work is out- or indoor (e.g. Rexbye et al., 2006). However, this item neglects leisure activities conducted outdoors or other UV radiation, such as visits to solariums. Future research is therefore encouraged to apply specific methods to assess sun exposure. King, Fan Xiang, Swaminathan, and Lucas (2015) point out that recent sun exposure is best assessed with dosimeters and sun diaries, whereas lifetime sun exposure is measured by microtopography of sun-exposed skin or proxies of sun exposure such as latitude of residence or ambient UV radiation levels.

13. Implications and Directions for Future Research

The present thesis provides important implications for future research by investigating the role of important bio-psychosocial factors in the relationship between facial appearance and dominance as well as mental health. The priority for future research should be to ensure a more detailed and individualized picture of the associations of facial appearance with both personality and health. This is important as previous research points out the risk of stereotyping and overgeneralizing facial cues, which can have serious consequences (see section 5.4). To further enhance our knowledge concerning facial appearance and its association with social dominance and mental health, a number of challenges needs to be addressed.

Previous and present findings indicate a strong link between fWHR and social dominance in the context of low social status. A first important issue that cannot be answered on the basis of the current state of research is how facial structure, particularly the fWHR, affects the way in which men migrate through social hierarchies. Our findings suggest that low-income men with a great fWHR perceive a discrepancy between their high need for status and their actual low status, resulting in a state of tension referred to as cognitive dissonance. This state of tension is supposed to get resolved by applying risk-taking strategies in order to (re-)gain social status. Future research will need to investigate whether those men actually find themselves in this expected state of tension or stress. Furthermore, other potential moderating factors, such as implicit motives of power or acute stressors (such as interpersonal or financial problems), could be taken into account to enhance the knowledge about the specific circumstances in which men in the constellation of the highest prevalence for applying risk-taking strategies resort to tougher measures, such as being aggressive or deceptive. Moreover, longitudinal studies are needed to investigate the impact of such risk-taking strategies on one's position in social hierarchy.

Referring to the vague link between fWHR and testosterone, future studies might gain new insights into the biological mechanisms underlying fWHR and dominance by considering multiple biological markers and their interaction (e.g. cortisol-testosterone ratio; Sollberger & Ehlert, 2016) or by extending research to biological processes beyond the endocrine system, for example by including neurotransmitter systems (e.g. dopaminergic and serotonergic system; Watanabe & Yamamoto, 2015) or specific genes (e.g. monoamine oxidase A gene; McDermott, Tingley, Cowden, Frazzetto, & Johnson, 2009) involved in social dominance.

Furthermore, future research is strongly encouraged to attain a more detailed understanding of the risk and protective factors for perceived facial aging. In particular, the potential beneficial effects we found for the psychosocial resources for mental health on perceived age should be investigated in more detail. As questions about the causal links between mental health and perceived age cannot be answered by the present research, one primary focus of future research should be to investigate the impact of mental health factors on perceived facial aging in a longitudinal design. In addition, an important issue that cannot be answered on the basis of the current findings refers to whether positive mental health states have a direct beneficial impact on facial appearance or whether their beneficial

effects occur due to buffering the potential detrimental effects of stress on facial appearance. To investigate this issue, future research should mainly focus on the valid assessment of mental health, stress, and perceived age. One possibility would be to obtain multiple measurements of stressors, psychosocial resources, and perceived age over a prolonged period. The application of an ecological momentary assessment would be helpful to assess dynamic risk and protective factors occurring in everyday life. With such a longitudinal design and more pronounced self-reports, future research will be able to draw more specific conclusions about the role of psychosocial resources, stressors, and their potential interaction in perceived facial aging. If the beneficial effects of the psychosocial resources for mental health on facial appearance can be confirmed longitudinally, appropriate interventions for promoting these psychosocial resources can be obtained and implemented to achieve positive effects on perceived facial aging and to support a healthy aging process.

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